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A HAMLET.

SIMLA HILL CULTIVATION.

By J. MOLLISON, M.R.A.C.,

Inspector-General of Agriculture in India.

THE Simla hill district has a total area of about 100 square miles. It occupies the Southern slopes of the great central chain of the Western Himalayas, and extends North and East from the Punjab plains in the Umballa District to the magnificent snow-clad peaks of the main chain. The annual rainfall is about 70 inches, of which the greater portion falls between June and September. July and August are generally the months of heaviest rainfall. The rains cease about the middle of September. A spell of genial weather follows. Snow usually falls several times in January and February. Hailstorms are common in March, April and May, and occur with considerable disaster to fruit trees occasionally in June. The mean temperature in Simla is 55°, that of January and February 41°, and that of June, the warmest month, is 67°. The lowest readings reached in the course of the year vary between the freezing point and 13° below it.

Most of the inhabitants in the Simla hills are agriculturists. These include the Brahmins of the lower order—the Kanāyats who are Rajput descendants—the Kolis and other low castes. The higher order of Brahmins and the Banyas are extensive landowners but do not directly cultivate. The Brahmin and Kanāyat cultivators are well-to-do. Their modes of life are similar and very comfortable. The Koli cultivators are poorer and have to live simply and economically.

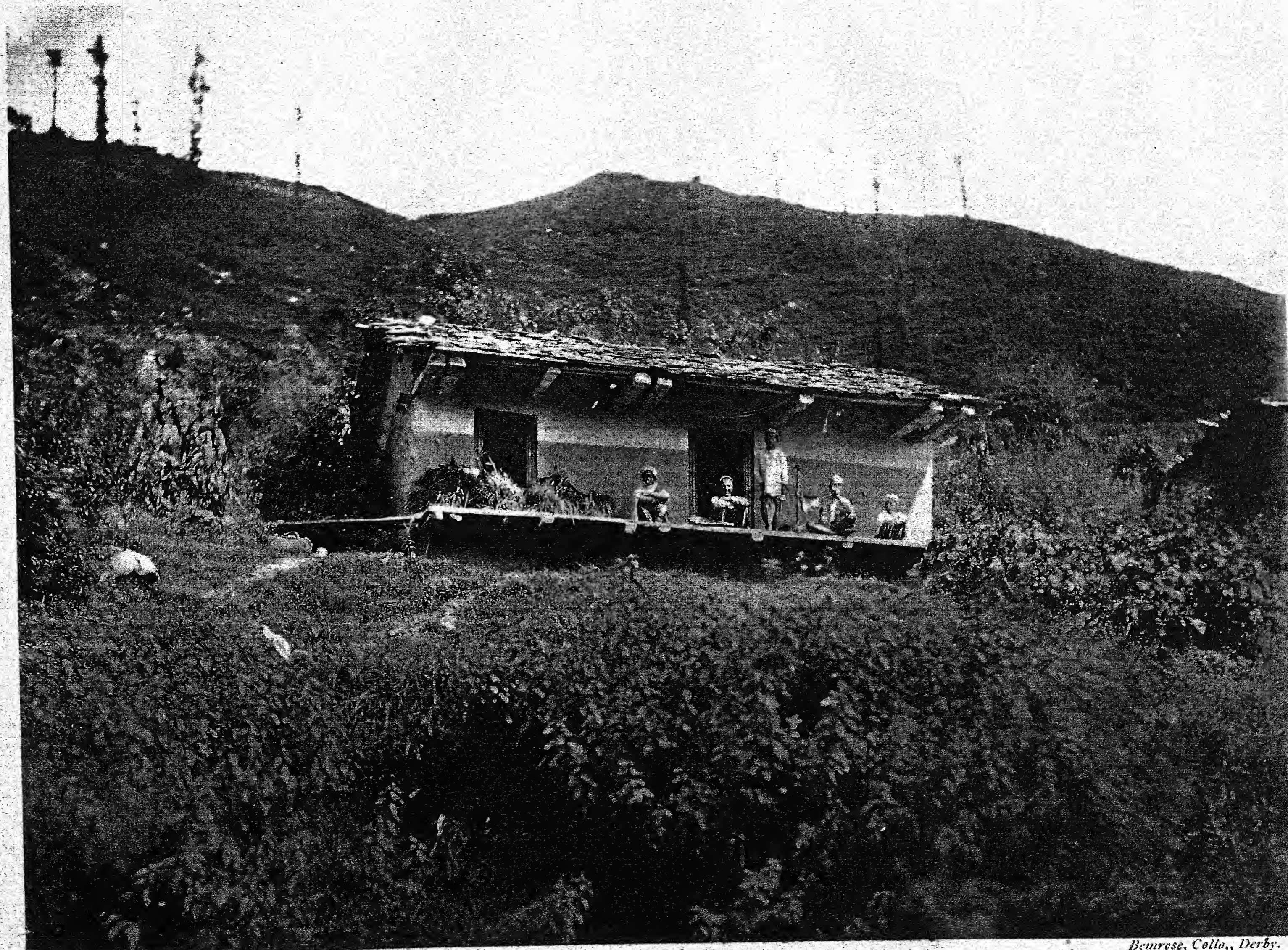
The cultivated land mostly consists of terraces which have been formed at large initial cost. The shapes and sizes of the

terraced fields depend upon the natural slopes and contour of the hillside. Where the natural slope is steep, the fields are fairly long and very narrow. In all cases the necessity of preserving a level surface for retaining rain-water and for irrigation, restricts the size and shape of each terraced field. Where the natural slopes are not very steep, the cultivated land is not levelled. The sloping fields are small, and erosion during the rains is prevented by stone and earthen embankments and by diverting the flow of natural drainage channels. Some fields are fenced with stone walls about 3 feet high or by hedges, the foliage of which is pruned for feeding cattle, sheep and goats when grazing is scant. Many fields, however, are unenclosed. Irrigation for the terraced fields is arranged for by tapping natural springs, by *bunding* hill streams, and by leading the water in open channels often long distances. In many cases numerous channels take off from a single stream. The majority are projected and maintained by the people themselves. There are no wells.

The dimension of a homestead indicates the circumstances of the cultivator. His holding generally surrounds his dwelling. The homesteads are generally scattered singly or in little groups in places where cultivation is possible. They are dotted here and there from the lower depths of the valleys, to the grassy uplands which in winter are much exposed to bitter cold. The arable holdings vary from 6 to 12 acres, and this area supports usually about 6 individuals, and with the common grazing a considerable number of cattle and other live-stock.

It is a satisfying sight to take a bird's-eye view from the higher ridges of the agriculture of these parts—particularly when the autumn tints prevail. The flag-roofed houses cosily built into the hillsides, the kale yards and the little orchards of each homestead, first catch the eye. The deep red patches of amaranth form a pleasing contrast to the little fields of yellow ripening corn. The autumn-sown crops helped by irrigation are fresh and green, whilst the pasture lands have taken a tawny hue. The little black cattle—the buffaloes, the sheep, and the agile goats—are industriously seeking pasturage along the network of

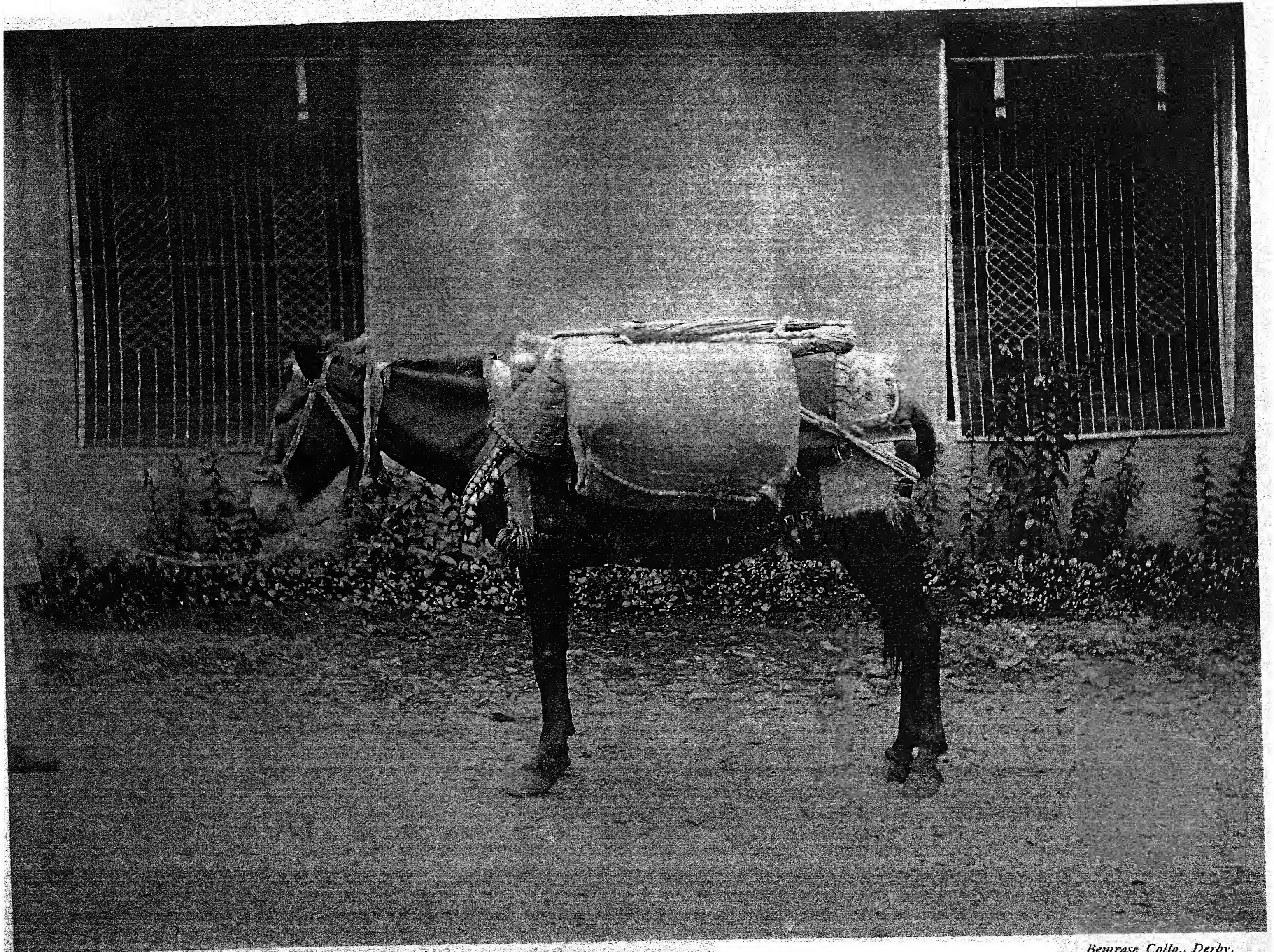
PLATE II.



Bemrose, Collo., Derby.

TYPICAL CULTIVATOR'S HOUSE.

PLATE III.



PACK MULE.

Bemrose, Collo., Derby.

foot tracks on the steeper slopes. These tracks possibly mark the footprints of cattle and sheep and goats, which have grazed on these hills centuries ago. Plate I is a rough sketch of a hamlet. The tall trees are pines from which the side branches have been ruthlessly removed for firewood—a common practice in the hills. Plate VIII represents a more typical hamlet. The terraced fields in the foreground are occupied by maize. The dwellings are scattered promiscuously over the hillside, each usually being isolated as in plate II. These isolated homesteads are guarded by large hill dogs which are dangerously fierce when approached incautiously by strangers. It is rare to find many homesteads close together; even the villages are small. The homesteads are grouped into circuits. Each cultivator usually builds his own house in a sheltered situation. The walls are built of stones, and are plastered inside and out with mud, and then limewashed. Each house has usually two stories. The basement is used as a cattle shed and general storing place for implements, fuel, etc. The family lives on the upper floor. The compartments are small, low and dark. This arrangement is a protection against cold but is quite insanitary. The roof is either covered with flat slate-like stones or with earth of a consistency which does not usually allow rain to penetrate. The cost of a house for an average family may vary from Rs. 500 to Rs. 1,000 each.

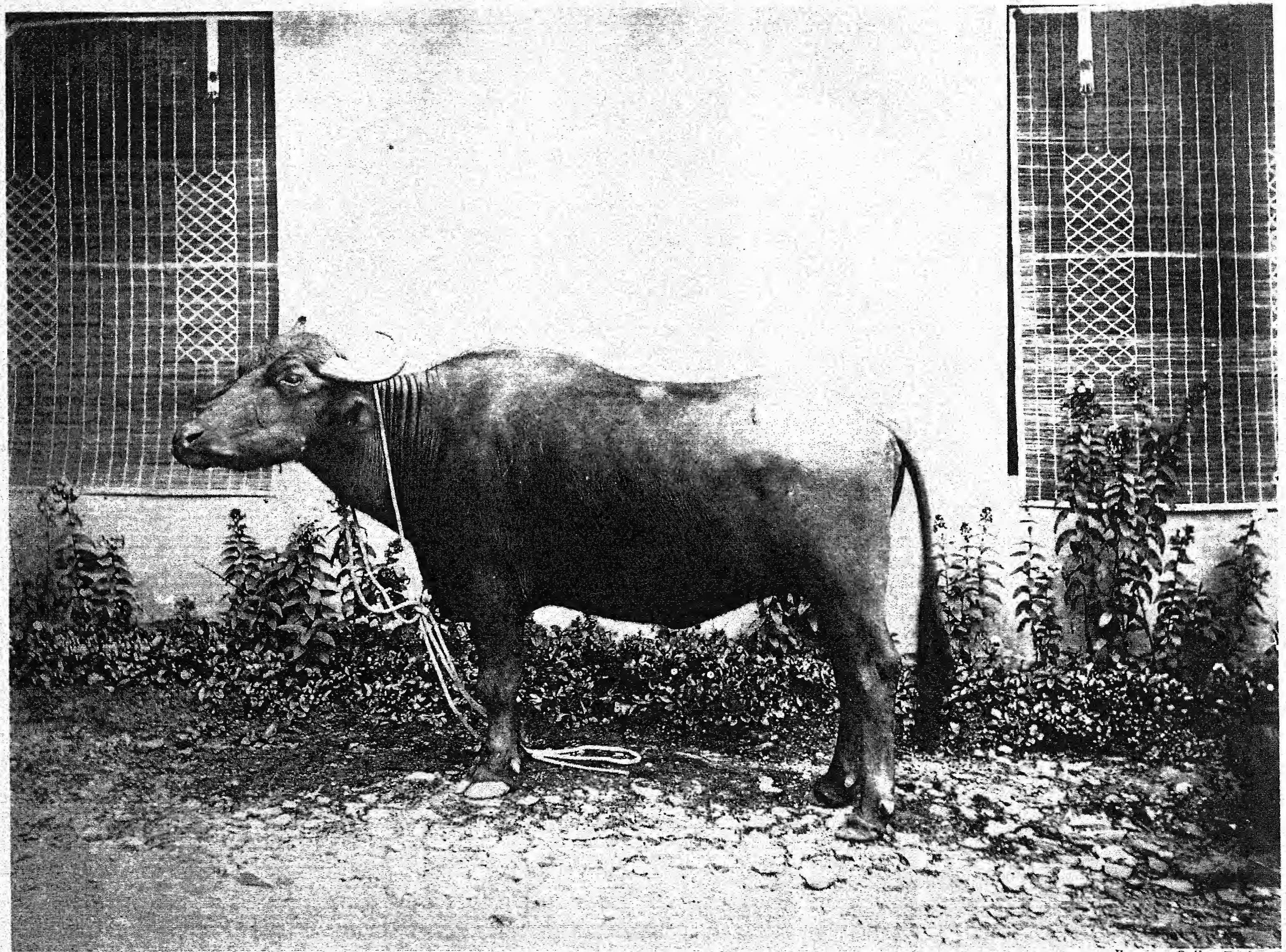
Hillside grazing is common to a circuit or to a group of families, but the grazing and hay obtained therefrom is not sufficient for the cattle and other stock. It is supplemented by grass and leaves gathered in forest areas. Some forest area is assigned to each group of families, but this does not lead to forest conservancy. Each landholder pays a small tax, not exceeding Rs. 2, for the right of cutting fuel.

The hill cultivators and their families are assiduous workers. The terraced fields are skilfully tilled. Crop after crop is taken in rapid succession. The fields are mostly double cropped each year. The best land, however, produces as many as three crops in 12 months The fertility of the land is, to some extent,

maintained by washings from the higher slopes, but fairly heavy dressings of ordinary manure are frequently given. This is possible for various reasons. The cultivator almost always lives on his holding, and the waste of domestic life goes on to the land. The number of farm animals which he keeps is much over the average of arable areas of like extent in the plains. The fodder and litter gathered in forest areas are considerable. The grazing lands are extensive and the manure from cattle, sheep and goats is to a large extent conserved. The intensive cultivation requires heavy manuring and the cultivators are fully alive to this necessity. The dung heap of each holding is usually some distance from the homestead. The cattle pens are littered with grass, leaves and small branches of trees, and this litter with the dung, the absorbed urine and the household waste, is carried to the general manure heaps every second or third day. This manure decays sufficiently to be applied at two seasons in the year, *i.e.*, for the Kharif as well as for the Rabi crops. Sheep and goat manure is considered to have high value. The professional shepherds bring their flocks down from the higher hills to the cultivated areas at particular seasons, and are paid liberally in cash or kind for folding the arable fields at night.

The farm implements are necessarily light to suit the draught capacity of the small active work cattle. They are efficient for keeping the land clean, for fine tilth, but are not heavy enough for deep cultivation. The ordinary bullock-power and hand-tillage implements are illustrated in plates IX, X, XI and XII. The former, though miniature, resemble those of the plains in general construction. Seed drills are not used, but seed is broadcasted or planted very evenly by hand. Numerous ploughings are given for spring-sown crops, but for second autumn-sown crops the plough is not used so often. The preparatory tillage is always careful. Most of this work is done by the plough (Plate IX), but a tined harrow (Plate X) and the leveller or clod crusher (Plate XI) are freely used. The latter, when used after sowing, helps to cover the seed and to form an even surface for irrigation. The terraced fields are generally so small and so level, that

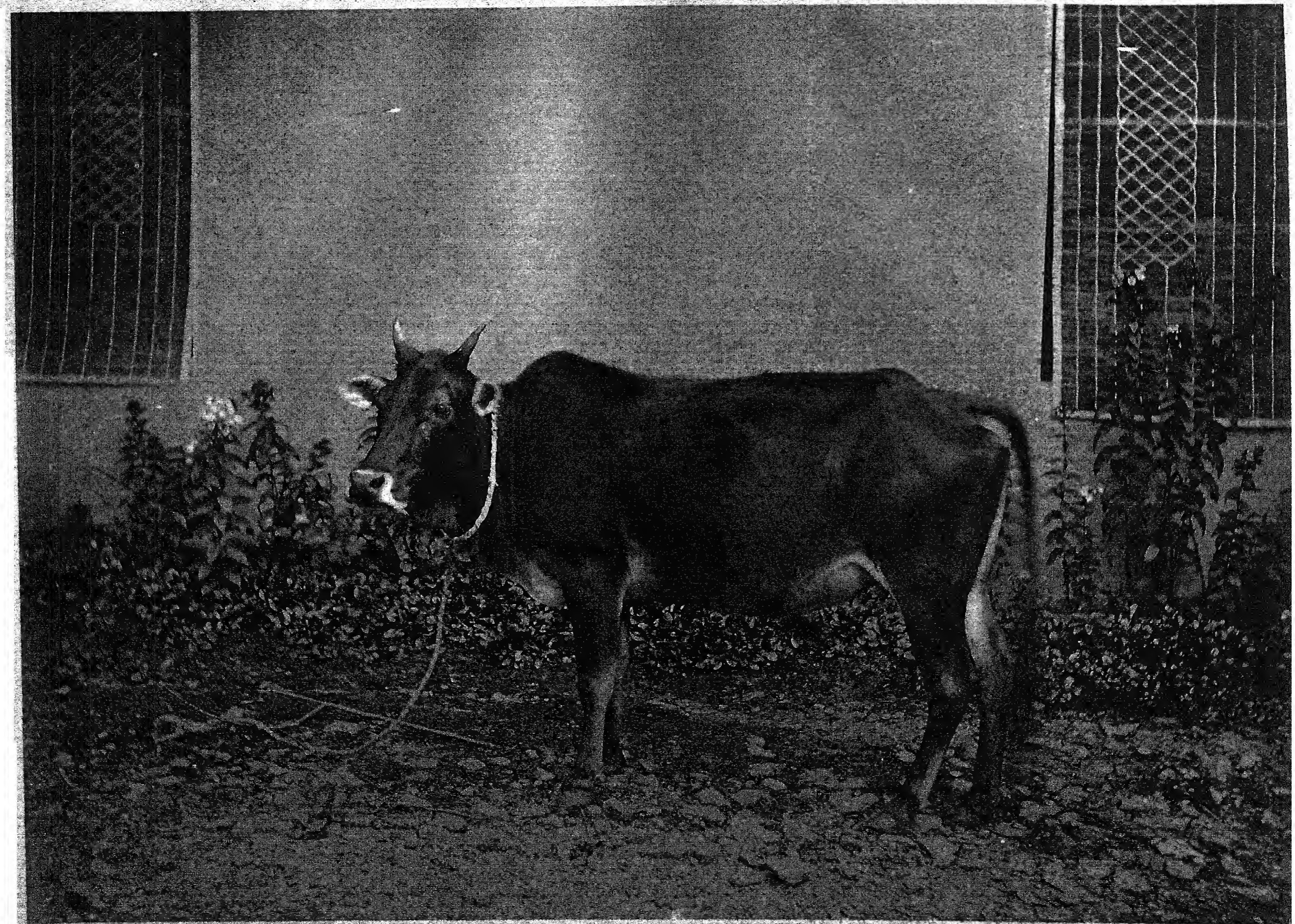
PLATE V.



HILL BUFFALO.

Bemrose, Collo., Derby.

PLATE VI.



HILL COW.

Bemrose, Collo., Derby

compartments for equal irrigation are only occasionally required. The crops are carefully handweeded. All grain crops are reaped with a sickle, tied into bundles and carried in headloads to the threshing floors to be threshed out under the feet of bullocks. Each floor is roughly paved with flat stones or with hard beaten earth, is surrounded by a low masonry wall and has a diameter of 15 feet or more. Bullock carts are not used in hill cultivation.

The arable produce available for sale is conveyed from the homesteads of the valleys by bridlepaths to the main roads and market centres by coolies or by pack animals. The general carrier of light weights is a cooly with a basket (Plates IV and XIII). The pack mule (Plate III) is often very heavily laden. The Hill coolies can carry astounding weights for long distances at a halting pace of 2 miles an hour or less. A heavy load is carried usually in a sack on the bent back and shoulders of the cooly, and is kept in position by a thick soft rope which is slung round the package and is supported on the cooly's forehead. Pack mules, pack ponies and pack cattle are chiefly used for carrying the agricultural produce which is exported. The long single files of these pack animals are very characteristic of the traffic of the main roads and byeways of the Simla hills. They not only carry agricultural, forest and other produce to the markets of the plains, but to a considerable extent they return laden with the merchandise of the cities of the plains and bring back spices, salt, tobacco and many other luxuries or necessaries. The principal *Kharif* crops are cereals: maize (makka), rice (dhan), kodra (*Paspalum scrobiculatum*), mandal (*Eleusine coracana*), urid (*Phaseolus radiatus*), mung (*Phaseolus mungo*), potatoes (alu), amaranth (*Amarantus rumentacius*), sesamum (til), turmeric (haldi). The chief *Rabi* crops are the cereals: wheat (gehun), barley (jau); the pulses: gram, lentil, and san (*Dolichos lablab*) and the oilseed sarson (rape seed). Walnuts, mulberries, peaches, apricots, apples and pears, are the more common fruits. In the rains a large variety of vegetables are grown in odd corners near the homesteads. They are chiefly native vegetables, but they include cabbages, cauliflowers, turnips, carrots, French beans.

English vegetables of fine quality can, with careful cultivation, be grown very successfully up to an altitude of 6,000 to 7,000 feet. The cultivation of fine varieties of fruit could be very largely extended. Potatoes of good kinds and of excellent quality are now produced in large quantities in the Simla hills. The cultivation is extending. The export trade of potatoes to the plains has been stimulated by the Simla-Kalka Railway and provides much transport work to coolies and owners of mules, ponies, buffaloes and bullocks.

In nearly all agricultural operations the women of the lower castes work quite as hard as the men. The older children help them to feed and tend the cattle, gather fodder and firewood, manure the fields, weed the crops, reap and carry home the harvest. The men do all bullock-power tillage, sow the seed, thresh and winnow the grain, carry the produce to market, and sell it. The women of the higher agricultural classes attend almost entirely to domestic duties only, and unlike those of the lower castes are not helped in their cooking by the men.

The staple cereal food-grains of agriculturists in good circumstances are wheat, maize, barley and rice, with the pulses, gram, urid, mung, arhar, math. Maize is the chief food between September and May, and wheat, or wheat and barley mixed, for the rest of the year. Potatoes are very generally eaten, also native vegetables, and a few of the more common English vegetables. Well-to-do families owning buffaloes and cows use a good deal of *ghee*. The poorer people are satisfied with linseed and rapeseed oil. Rock salt is the chief form of salt used. Men and women smoke tobacco, but the higher ranks refrain from doing so openly.

The income derived from cultivation by a large family on a small holding is supplemented by that from subsidiary occupations, as for instance selling fuel and grass obtained in forests, carrying the agricultural produce of the larger landowners to market, and in grinding grain. Plate XIV illustrates a flour mill which is common in the hills. It is worked by water power. The water is diverted from a stream, and by channel and wooden lade is

PLATE VIII.

A. J. I.

A TYPICAL HAMLET.

PLATE IX.

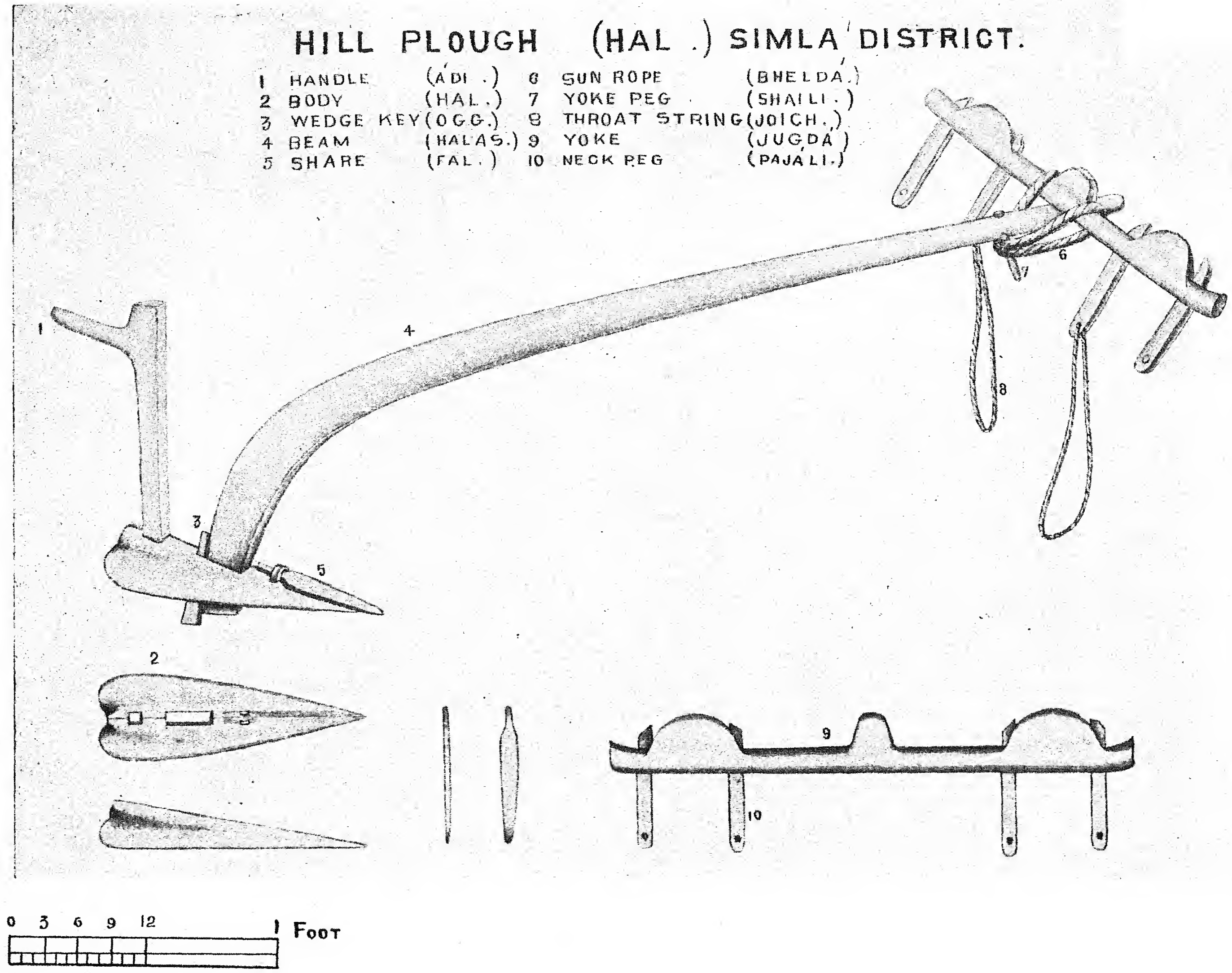

HILL PLOUGH (HAL.) SIMLA DISTRICT.
1 HANDLE (ADI.)
2 BODY (HAL.)
3 WEDGE KEY (OGG.)
4 BEAM (HALAS.)
5 SHARE (FAL.)
6 SUN ROPE (BHELDA.)
7 YOKE PEG (SHAILI.)
8 THROAT STRING (JOICH.)
9 YOKE (JUGDA.)
10 NECK PEG (PAJALI.)
1
2
3
4
5
6
7
8
9
10
0 3 6 9 12 1 FOOT

PLATE X.

HARROW (GAHÁN OR DANDÁL.) SIMLÁ DISTRICT.

1	BEAM	(TANGDA.)	5	ROPE	(BHELDÁ.)
2	BODY	(GAHÁN.)	6	YOKE PEG	(SHAILI.)
3	PRONGS	(GHADANDÁ.)	7	NECK PEG	(PAJÁLI.)
4	YOCK	(JUNGDÁ.)	8	THROAT STRING	(JOICH.)

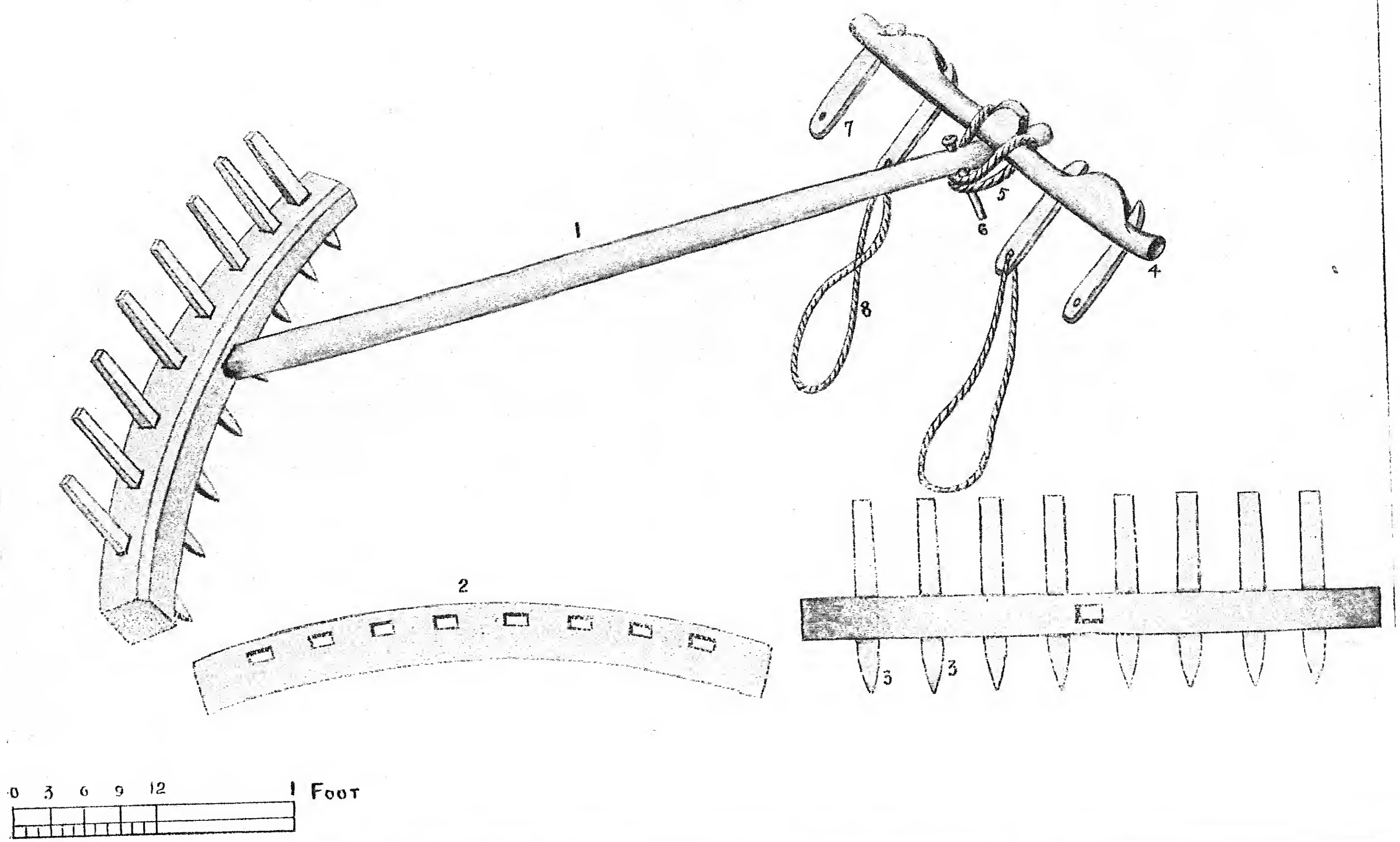
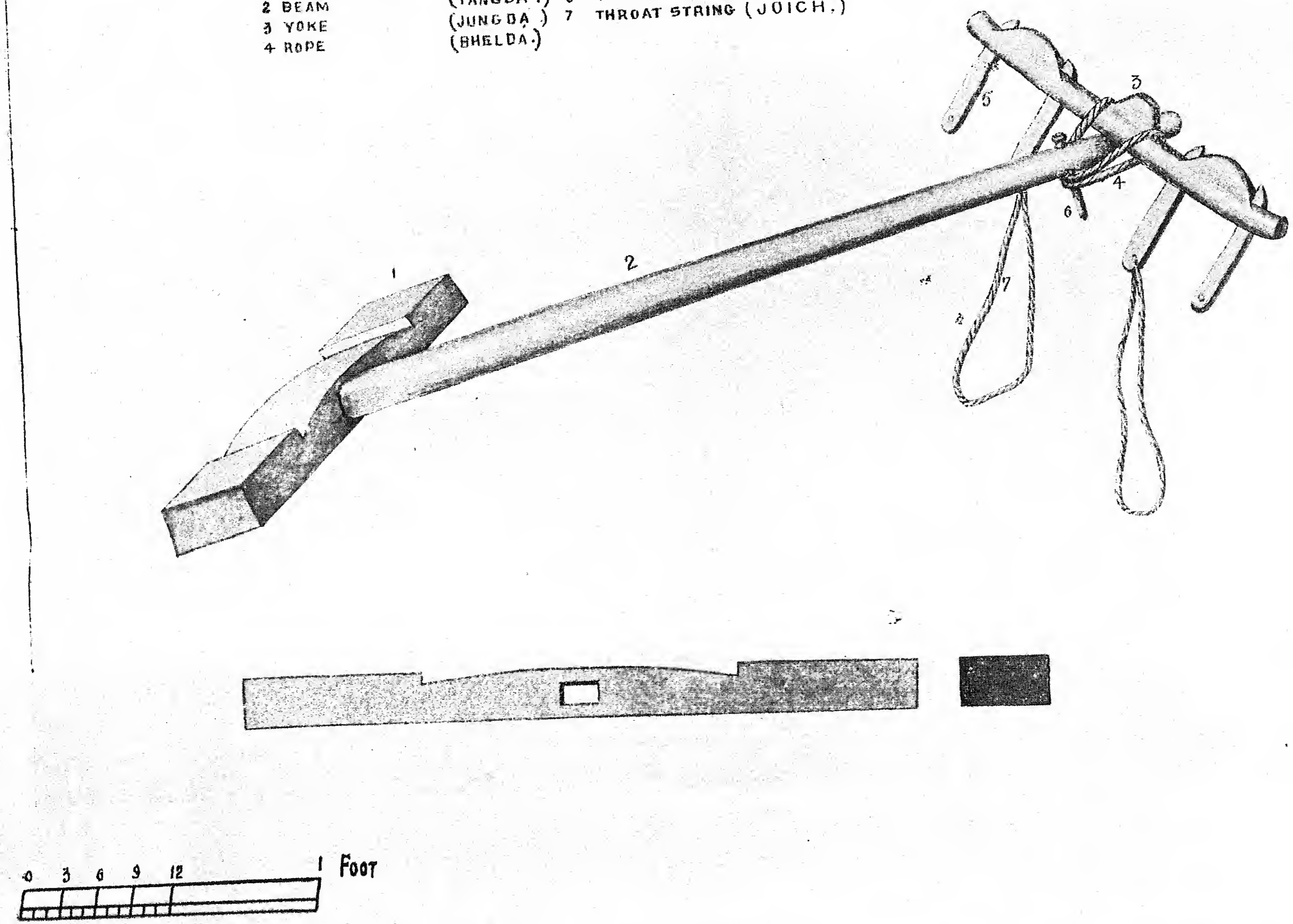


PLATE XI.

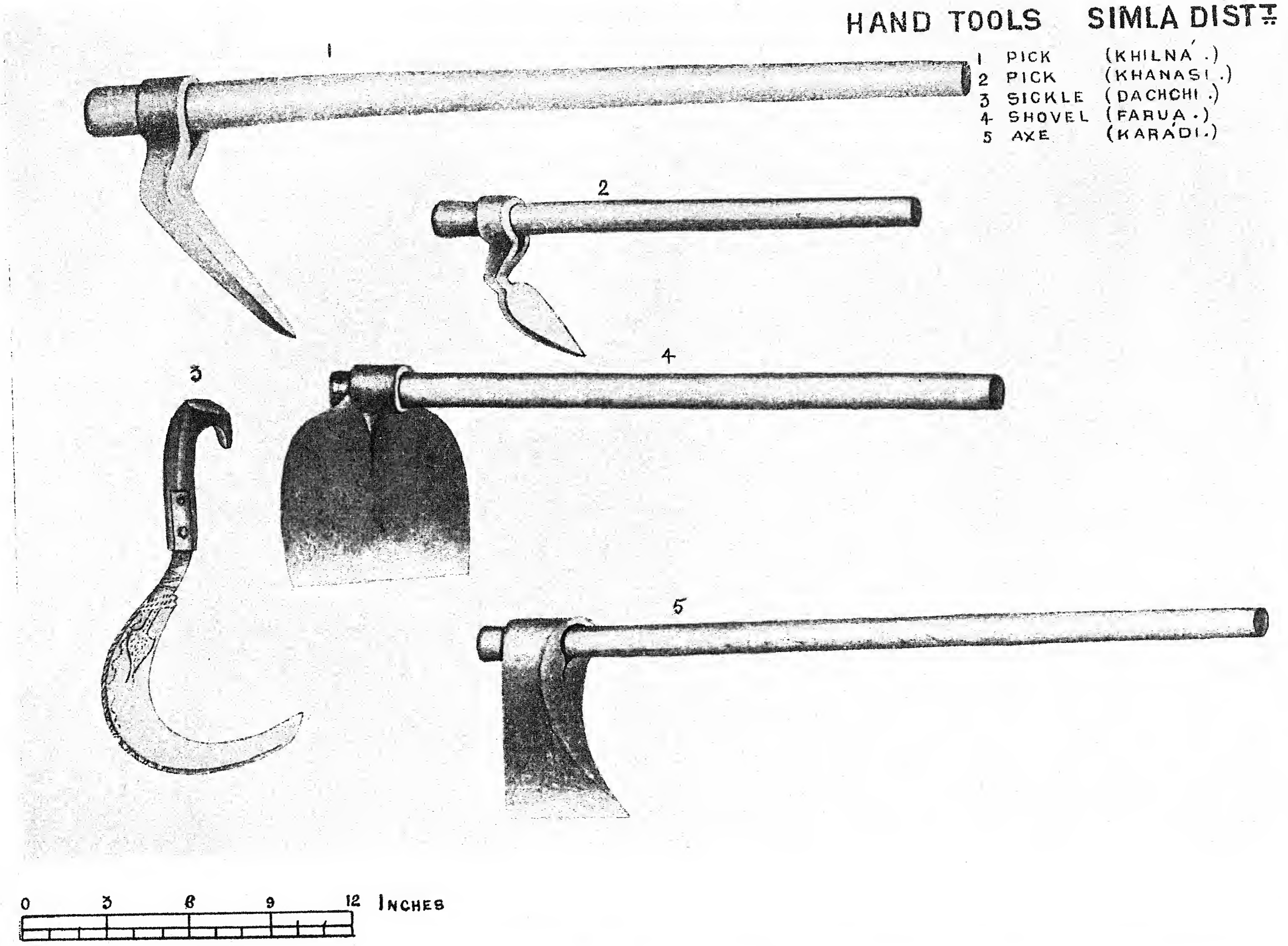
LEVELLER (MOI.) SIMLA DISTRICT.

1 WOODEN LEVELLER	(MOI.)	5	NECK PEG	(PAJALI.)
2 BEAM	(TANGDA.)	6	YOKE PEG	(SHAILI.)
3 YOKE	(JUNGDA.)	7	THROAT STRING	(JOICH.)
4 ROPE	(BHELDA.)			



A. J. I.

PLATE XII.

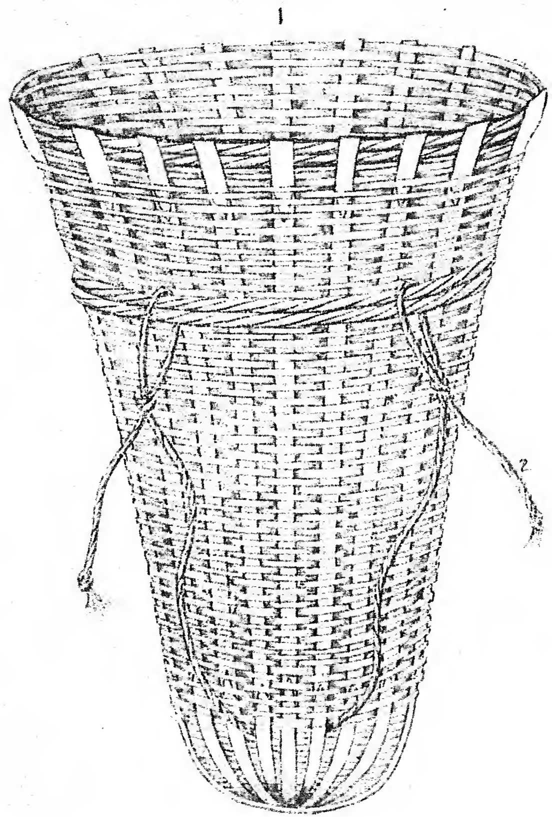


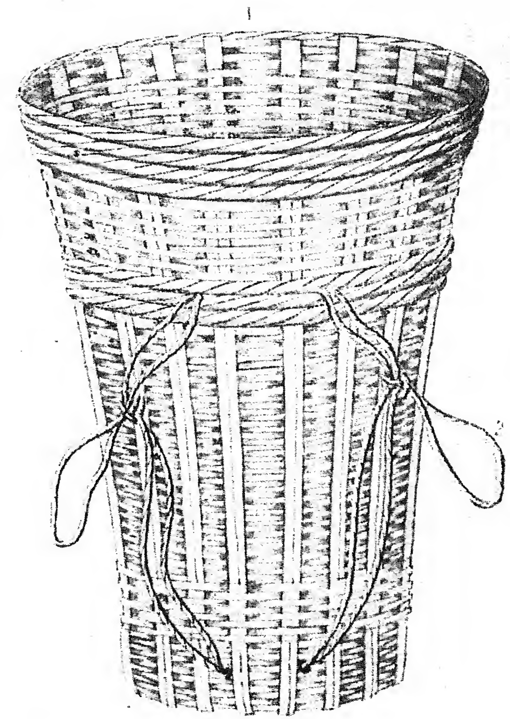
A. J. I.

PLATE XIII.

BASKETS . SIMLA DISTRICT.

(for carrying agricultural produci.)





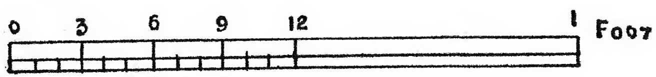
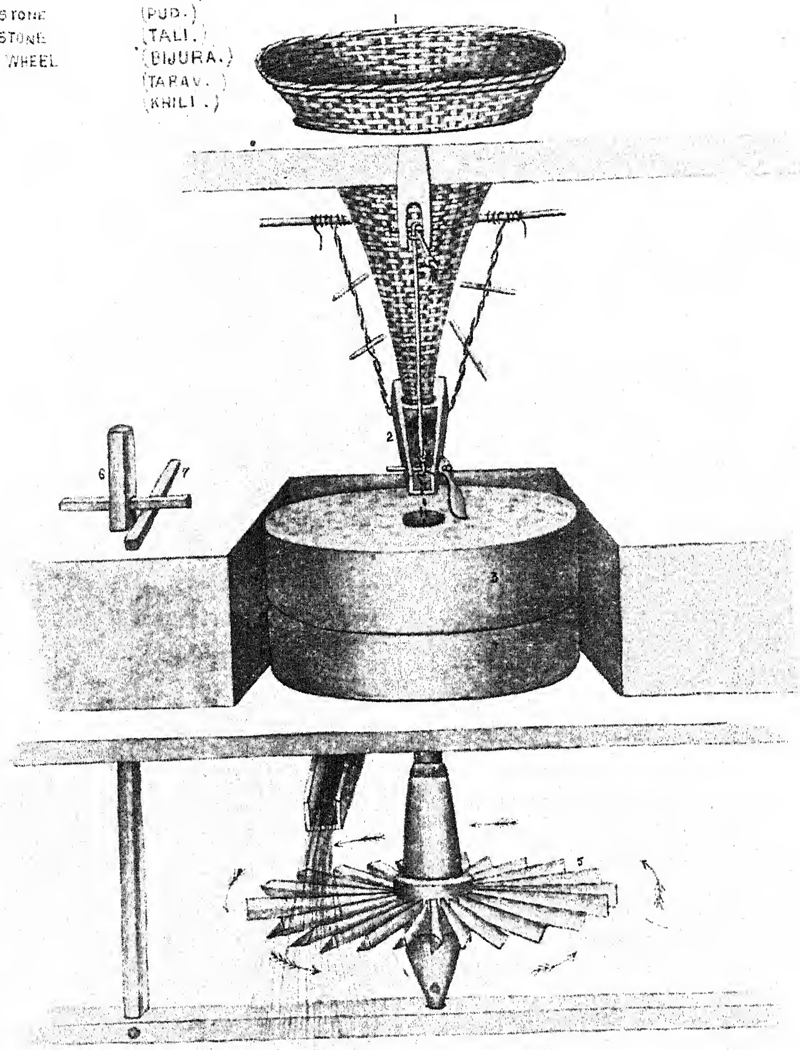


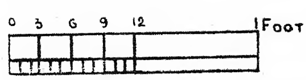
PLATE XIV.

GRINDING MILL (GHARAT) SIMLA DIST^{T}.

(worked by water power)

1 FUNNEL (WICKER WORK) (GATIL.)
2 FEEDER (NALI.)
3 UPPER STONE (PUD.)
4 LOWER STONE (TALI.)
5 TOOTHED WHEEL (BIJURA.)
6 LEVER (TARAV.)
7 WEDGE (KHILI.)



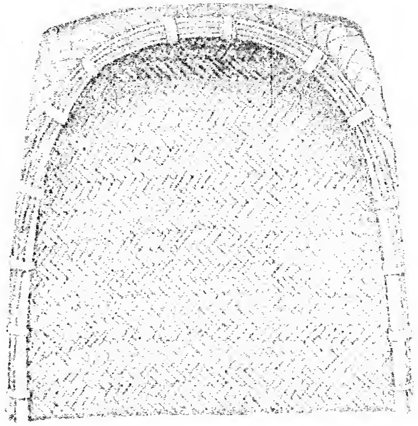


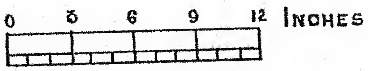
A. J. I.

PLATE XV.

MORTAR, PESTLE & SUP. SIMLA DIST^{T}.

(for pounding & winnowing rice. &c.)





carried with sufficient fall and force to work a turbine wheel which moves the nether grindstone. A mill including the hut over it costs about Rs. 30. The grain which is usually ground is wheat, barley, maize and gram. The usual rate for grinding is two annas per maund of 82 lbs.

Plate XV illustrates the mortar, pestle, and sup used for pounding and winnowing rice and other grains. The women use the sup very deftly in separating chaff and husk from grain and in sifting husk from pounded grain or flour.

Plates V, VI, VII, respectively, illustrate a hill buffalo, a hill cow, and hill sheep. The hill cows and work cattle are compact, active, little animals, not unlike the Kerry cattle of Ireland, in size and general conformation. They vary in colour, but the majority are black or very dark brown. A good cow is worth about Rs. 30, but only yields about 3 seers (6 lbs.) of milk when in full profit. The buffaloes are much smaller and more active than those of the plains. A milk buffalo costs Rs. 40 to Rs. 50 and gives about 5 seers (10 lbs.) of milk daily for a few months after calving.

The hill mules are very sturdily built and of very fair size. Many are well over 13 hands in height. They are worth 60 to 80 rupees each. A good donkey mare is worth Rs. 150 or more.

THE CATTLE AND SOME AGRICULTURAL FEATURES OF THE KURNOOL DISTRICT.

By C. BENSON, M.R.A.C.,

Late Deputy Director of Agriculture, Madras.

The Government of India, in their Resolution of December 1881 on the Report of the Famine Commission, expressed the opinion that the primary duty of the Provincial Agricultural Departments then being organized should be an analysis of all districts, village by village, in order to determine in which portions of the country agriculture is precarious and also to ascertain what agricultural defects exist. In Madras, some years ago, this task was entrusted to me and took the form of a general survey rather than more precise village to village analysis.

The only district dealt with was Kurnool. It was for purposes of enquiry divided into fairly homogeneous tracts or agricultural divisions regardless of the artificial boundaries of administrative areas, and the condition of these tracts was submitted to a detailed analysis as time and means permitted. From an agricultural point of view, the advantages of adopting such a system are many and obvious, particularly in illustrating by facts and statistics the teachings of Indian rural economy. I propose to show something of what I then learnt, especially about the farm livestock of the Kurnool district.

This district has an area of over 7,500 square miles, one-third of which is occupied by forests. The greatest length from north to south is 80 miles and from east to west 110 miles. Over such a wide area it is natural that great diversity should exist, and this diversity is increased by the fact that the district is traversed from north to south by two ranges of hills—of no

great height it is true—but sufficient to intercept and modify the flow of the monsoon currents and hence the rainfall and its distribution. Added to this, the soils are many and varied, and thus the agricultural conditions of different parts of the district are also diversified. In no respect are they more so than in regard to cattle-breeding and management. In some parts cattle are largely bred ; in others, there is practically no breeding at all, and the ryots depend for their work cattle on imports from the neighbouring district of Nellore (or Ongole).

Speaking generally, the district stands from about six to sixteen hundred feet above sea-level, with hills in some places exceeding 2,000 feet in altitude. It is occupied almost throughout, except on the north-west, by sedimentary rocks which largely influence the character of its soils. The irrigational facilities are mostly poor and not capable of great development; though in some tracts the underground water-supply is good and might be more largely used than it now is. The rainfall is moderate and precarious. It is only within comparatively recent years that access to the district by rail has been provided, whilst other communications are poor in many parts, though their quality depends largely on the nature of the soil in different localities. The population, though at first sight appearing to be extremely sparse, is not so in reality, for the incidence is reduced by the large area of forests that exist. The population is fairly uniform throughout the district as a whole. In parts there is much good soil, but the precarious character of the rainfall has rendered the Kurnool district one of the worst 'famine' districts in the Madras Presidency, and agriculture is carried on there under great difficulties.

It is not with agriculture generally that I propose to deal in this paper, but with the cattle of the district. And in this choice I think there is reason, for on his cattle the ryot depends almost entirely. They are the motive force for nearly all tillage operations and the source of the greater part of the manure he uses, and thus they are of outstanding importance in the rural economy of India. Little effort, however, seems to have been

made to collect accurate details about cattle in any Province in India. I have long been convinced that, in Madras at least, the data available for forming an opinion of the tilling and manuring forces of cattle were utterly defective—any figures the village accountants chose to submit being accepted without check or question. One of the first things that was before me, therefore, was to obtain fairly full and fairly accurate statistics on this matter. It involved much labour and the detailed checking of many hundreds of returns. The result was not without its value, for I believe that, in my account of the Kurnool district, I placed on record data which should serve as a general check on livestock statistics as prescribed by village accountants.

In the course of my survey, I divided the district into nineteen agricultural tracts. Some of these were of comparatively small area, one, the conditions of which are governed by the existence of a large irrigation tank, being only 13,750 acres in area ; but most of them exceeded a hundred thousand acres in extent, whilst some were three or four times as large again. Each of these tracts differed in some important agricultural character from those adjoining it, though differences of soil chiefly influenced the grouping adopted.

I propose to deal in this paper in detail with two only of the 19 tracts. Of these, one, with an area of nearly 424,000 acres, is a wide open plain of *régada*, or black cotton soil. The country is fertile and the people comparatively prosperous. It is almost treeless except where the villages cluster along the main watercourses, and irrigation is confined to one or two tanks. Irrigation from wells is scarcely practised, there being about 177 acres of crop grown without for every acre irrigated from a well, and the soil is not generally of a character suitable for irrigation. The principal crops of the tract are a late variety of sorghum and cotton. At the time of my survey, about 17 per cent. only of the total area was not available for cultivation, and of this nearly half was included in village forests and grazing reserves. Besides such area and a very small proportion of the occupied land left untilled, there was no public grazing easily accessible to

the ryots. Forests at no great distance are, however, grazed by ryots' cattle in times of drought. Within the tract, at the time, 96 per cent. of the arable land was in occupation, and of this the normal proportion cultivated from year to year was 94 per cent. Nearly the whole of this cultivated land depends on rainfall only. The average assessment of the unirrigated occupied land was then very slightly over one rupee per acre. The holdings averaged about fifteen acres each, 12 per cent. of the area was held in occupancies of about three acres, and 25 per cent. in holdings of the average of 15 acres. The tract shows quite a number of large holdings for Southern India.

The other tract with which I propose to deal has an area of about 320,000 acres, generally of thin poor soils, though a few patches of superior quality exist. This tract forms a plain lying outside the Eastern Ghats with valleys running up into the Nallamalais. The tract is almost bare of trees and is surrounded generally by the bare foot-hills of the Nallamalais. The accessibility of the higher jungles on those hills encourages the keeping of stock. Besides the more distant jungles alluded to, of the total area there was at the time of my survey some 27 per cent. reserved from occupation, of which nearly half was then included in village forests and grazing reserves. 66 per cent. of the arable area was then in occupation; therefore, rather more than half the total area included in the villages of the tract was available for public or 'common field' grazing; and besides this, on an average of years, over 20 per cent. of the land in occupation was not tilled. The greater part of the cultivated land in this tract depends chiefly on rain, about 5 per cent. was irrigated from works, and more than 10 per cent. from wells. The well irrigation is a very important feature of the tract. The quality of the land in occupation is shown by the rate of assessment, *viz.*, 8 as. an acre. The value of well-irrigation has not enhanced the assessment. In this tract crops are earlier than in that previously mentioned; nearly two-thirds of the sowings occur before the end of August, a good deal, however, of really late sown crop is also raised, as the tract receives a fair amount of rain during the north-east

monsoon. Cereals, of which the most important are Sazza (*Pennisetum*), Korra (*Setaria*) and early sorghum, pulses—chiefly horse-gram (*Dolichos*)—castor and cotton are the chief crops. The two latter occupied about 15 per cent. of the cropped area. The holdings are small, averaging all round only ten acres in extent. More than half the area had holdings that averaged about seven acres ; only 34 per cent. had holdings which averaged about 18 acres. There are practically no large holdings in this tract.

From the description given above, it will at once be recognized that the two tracts, which I named respectively the Kundér and Dupád tracts, are, agriculturally, as the poles asunder, and this is even more marked when matters relating to livestock are considered.

In the first place, with regard to the areas kept under cultivation by a pair of working cattle, in the Kundér tract, this is as much as 34 acres and in the Dupád tract only 13. To some extent this is explained by the fact that in Dupád there is so much irrigation from wells, but that is not the only or the chief reason for this remarkable difference. On the rich cotton soils of the Kundér tract, the tillage is most astonishingly superficial and slight, though in this respect it is more complete than is the tillage in other parts of the district and in Bellary, which adjoins it on the west. In the Kundér tract, tillage, though the plough is used to a considerable degree, is mainly dependent on the drill and harrow (Guntaka), whilst in Dupád the plough is much more generally used, and the consequence is that the tillage in the former area is quite shallow and is not corrected by occasional deeper tillage as in the Bellary country. In the tilling force itself there is a difference, for whilst in the Kundér tract only about 3 per cent. consists of he-buffaloes, in Dupád the proportion of this kind of stock is as high as 18 per cent. To some extent this difference is attributable to the larger proportion of irrigated land in the latter area, even though the buffalo is not a suitable beast for use on the thin stony or gravelly soils that occupy the greater part of it.

When the next particular detail is alluded to however, the difference between the two tracts is more clearly shown ; for whilst in the Kundér tract the proportion of breeding cattle to working cattle is as 126 to 100, in Dupád it is as 221 to 100. In the latter area the proportion of breeding cattle is possibly under-stated, as many of the cows are sent off to the higher jungles for grazing and cannot readily be counted. The proportion of breeding cattle to work cattle in the Kundér tract is enhanced by the large number of she-buffaloes which are kept. In this tract, we found nearly twenty thousand breeding she-buffaloes and only about 5,400 cows. In Dupád, on the other hand, there were about twenty-four thousand cows and less than thirteen thousand she-buffaloes. Of the progeny of the she-buffaloes, only some six hundred were reserved in the Kundér tract for working, the unirrigated land being almost invariably cultivated with oxen. The small number of these bred locally was altogether inadequate to local requirements, which are met by importation from the east—chiefly of Nellore, or Ongole cattle. These cattle are bred in the northern part of the Nellore district and in the adjoining parts of what is now called the Guntur district. They are brought over when from 18 to 24 months old, in droves which travel through the district from east to west, and are sold on an instalment system, the payments being spread over three years, so that the debt on a young bull is cleared by the time he comes into full work. During their growing years these young bulls—they are not castrated till their fifth year—are carefully fed and looked after, being treated very much as members of the ryot's family, and the better the condition of the owner the better fed will the young stock be. Besides an abundant supply of sorghum straw, these young bulls receive about half the ration of artificial food allowed to the tilling cattle, and green fodder when it is available. In consequence, it is perhaps on the rich cotton soils of the Kundér tract that this noted breed reaches its greatest development. These cattle, owing to soft feet, are better suited to black cotton soils than to gravelly soils or for road work.

My account of the Kurnool District gave, I believe, the first close estimate of the numbers of young stock kept or raised in any district in India. I arrived at the conclusion that ordinarily we should find about 135 young cattle for every 100 breeding cows kept, and that in the case of buffaloes the proportion is rather lower, owing to the greater delicacy of the buffalo calf. In the two tracts which I have taken for detailed reference, we found that the proportion of young stock to cows was as 143 to 100 in the Kundér tract, and as 94 to 100 in Dupád; the low proportion in the latter being attributable to omissions, and the high proportion in the former to the importation of young working cattle not ready for the yoke. In the case of young buffalo stock, the proportions in both tracts were almost identical, being 108 in the Kundér and 110 per 100 buffalo cows in Dupád. The importance of obtaining accurate data on these points lies not only in the matter of how supplies of tillage cattle are maintained, but also in the demand for grazing, if they are to be reared locally. In Kurnool, the cows and young stock (except the imported young bulls alluded to above) have, under all circumstances, to trust almost entirely to what they can pick up on the common pasture for their food. The she-buffaloes, on the other hand, like working cattle, form part of the ryot's family; and whilst in milk, receive great care and attention. Dry and young buffaloes are, however, not specially fed, but they are housed at night and get a little straw to eat.

The importance, therefore, in the economy of any tract or district, of the grazing areas accessible thereto, is at once apparent. These include the lands reserved for communal purposes, the unoccupied arable land, and what, at the time of my survey, were called "village forests and grazing reserves." Taking all the cattle as full grown,* the numbers maintained, including the working cattle, were 82 head per 100 acres of grazing area in the Kundér tract and only 44 in Dupád. In the former tract, they were mostly working cattle and she-buffaloes; in the latter, breeding

* After reducing the young stock by one-half.

cows formed the largest item. But the difference in the practice of the two tracts is more definitely shown by the numbers kept in proportion to the areas cultivated. These were 22 only in the Kundér tract and 100 in Dupád per 100 acres normally cultivated. These figures show that, whilst the people in the Kundér tract devote their attention to tillage (with the keeping of buffaloes primarily for milk), those of Dupád to a very large extent depend on cattle breeding for their subsistence.

I have now to deal with the manuring capacity of the stock in the two tracts. In so doing, and to form a rough estimate, it is necessary to note the number of stock kept, calculating young animals at half. If, then, we allow a little more than one load of dry dessicated manure per head as the annual amount available, we get the following results :—

Number of stock kept—523,139—giving 600,000 loads per annum. Total area under crop annually about 1,700,000 acres. This gives 30 loads available for 17 acres once in five years, or less than 2 loads per acre. As, however, the gross amount available for ordinary dry land must be reduced by the amount taken annually for the irrigated and garden lands, the remainder really available for ordinary 'dry' lands may be determined somewhat as follows :—

Total amount available	600,000	cart loads.
Amount required for 30,000 acres manured annually	300,000	cart loads.
Remainder available for 1,650,000 acres occasionally manured	300,000	cart loads.

That is, about one cart load is available per acre once in five years for most of the land. In other words, only 60,000 acres of the land is manured in a year from this source and 1,370,000 rarely, the latter being the land most remote from the villages.

In working out the extent to which manuring from this source is possible, allowance may be made for the conditions influencing the probable amount available and the demands thereon in each tract. Thus in Dupád considerable allowance has to be made for the practice of driving off the young and breeding stock to the jungles for pasture ; and a deduction must

also be made there for the demand made for the irrigated and garden lands before any estimate can be made as to how much of the ordinary 'dry' or unirrigated land is manured. Nevertheless, the stock kept in proportion to the whole area under cultivation is the safest measure of the extent to which manuring is generally carried out. In the Kundér tract, the total stock kept was only 22 per 100 acres cultivated, whilst in Dupád it was one for every acre, and whilst I estimated that in the former tract 14,000 acres could be manured from this source, in Dupád I put the figure at 10,000 acres yearly. Adding on the manuring power of the sheep and goats, of which very large numbers are kept in Dupád, the total manuring power available, whilst reaching to only 6 per cent. of the cultivated area in the Kundér tract, was as high as 26 per cent. in Dupád; but, after making the necessary allowances mentioned above, I was inclined to place it at 15 per cent. of the cultivated area in Dupád, while in the Kundér tract I placed it at not more than 5 per cent. of that land. These estimates are, it must be remembered, based on an application of five cart loads per acre only, or its equivalent in manure from sheep and goats.

Whether my estimates of the outturn of cattle manure per head is low or not, and it was based on very extensive and minute enquiries, the conclusions are, I venture to think, of some considerable value, and apply in Southern India to the possibilities of manuring dry or unirrigated crops, which are those on which the bulk of the ryots depend for their subsistence.

In some parts of the Kurnool district, on or around the foot of the two ranges of hills, considerable herds of breeding cattle are kept by professional cattle breeders, the Lambadies, who in former times did a great trade as carriers with pack bullocks. In the same localities, as well as in another, where there is a large amount of grazing available, such breeding is pretty extensively practised by the ryots. She-buffaloes are kept almost everywhere and their produce, in ghee, is considerable, especially in the tracts where the black cotton soils prevail.

He-buffaloes are not largely used for tillage, except where 'wet' cultivation exists or where there is much irrigation from

wells, but they are generally used by the quarrymen and woodmen for hauling stone and timber. Bullocks form almost entirely the tilling power of the district and are generally remarkably good. Nellore cattle preponderates in the greater part of the district, except on its western side where locally bred cattle are chiefly used. In the eastern parts also, locally bred cattle prevail, but these often show the Nellore type strongly.

Within the district, besides the usual mongrels, two distinct breeds are to be found ; one on the stony hills or table-lands in the south-west of the district, and the other in the jungles lying about and to the north of the Kistna river. The former, which for convenience may be called the 'Erramala' breed of cattle, are of medium size, very active and spirited. They carry long sharp-pointed horns, which in good specimens should meet at their tips. They are renowned for their hardiness and endurance, and when well trained, they are excellent for fast road work. They are not much seen at the plough but are used as pack bullocks. The soundness of their feet enables them to travel long distances by road or on hard gravelly soils without needing shoeing. The latter breed, which may be termed the 'Dupádi', resembles the Erramala cattle in type and character, but are rather smaller. The prevailing colour is pale red. These cattle are remarkably shapely and are of great power and pluck. They are brought southwards for sale from the Kistna Jungles and are largely used by their breeders, the Lambadies, in carrying salt and firewood. The more nearly the locally bred cattle approach in character to either of these two breeds, the more valuable they prove. It is seldom that the cattle in the central or western parts of the district show much sign of Nellore blood. These local cattle are far hardier, more active, and longer-lived than the Nellores, and stand a rough life and hard usage well, whilst, on hard work, they do not need nearly so much artificial food to keep them in condition. They form the bulk of the tilling cattle on the lighter soils and of the cart bullocks on the roads.

In choosing cattle, great attention is paid to colour. Local cattle having the colour of a grain of wheat are the most valued; the whites, reds, and blacks following in the order given. Cattle with short legs, horns, and neck are preferred. A saying goes "purchase without further enquiry a bull with thin horns." The value of a spirited animal is also recognised, for it is said, "a willing bullock is hardest worked," or that "one word is enough for a good man, one stroke for a good bullock." As to the relative qualities of bullocks and buffaloes, it is said that "a good working buffalo is not equal to a dull bullock."

As to the housing of the cattle, over the greater part of the district one-half of the ryot's house forms his dwelling and store rooms, the remainder his cattle byre. Ventilation, especially at night when the door is closed, is practically non-existent. The floor is usually paved with slabs of slate and soon becomes uneven, and the provision made for carrying off the urine of the stock is most ineffective. From June to March, most cattle are housed thus at night, but during the hotter months, the men sleep in the open and the cattle are, as far as possible, tethered outside. In those parts of the district where good building stone for the construction of the usual flat-roofed houses is not to be had, the ryot either shares a portion of his thatched hut with his cattle, or provides another, equally good, for them. The walls of these sheds are usually made of wattles and thus they are well ventilated, but the floors are even more defective in regard to the preservation of the urine, than in those parts where stone is available. The housing alluded to is provided for the tilling cattle, the young bulls, and the she-buffaloes. When the number of cows kept is small, they are similarly housed with their calves, but when the numbers are considerable, they are penned in an open yard. The professional breeders tie their cattle up in rows in the open, the camps being moved from place to place as convenience dictates, the chief point being the water-supply in the dry weather, but in the rains accessibility for grazing is the only consideration. Thus, these breeders spend

their time between the jungles on or around the hills and in camps in the plains, after the harvests are over.

As regards the working cattle, the management varies slightly according to the accessibility or otherwise of grazing, but they are seldom sent any considerable distance for grazing and are usually herded separately from the other stock. The ryot recognises that "it is straw that makes the ox grow fat." When grazing is available, the cattle are turned out at the early hour when the ryot rises and grazed till about 8 A.M., and again after the day's work, till as late as 8 P.M. when they are brought in and tied up. Elsewhere they are first fed at about 4 A.M. and do not generally go out to work until the drivers have taken their early meal. At midday they get a feed of sorghum straw. They are brought in at about 5 P.M., and, after being watered, are tied up for the night and given a feed of sorghum straw, and their mangers are filled with a mixture of korra (*setaria*) straw and *pottu* (a mixture of the pods of leguminous crops and other chaff), when the ryot goes to bed. This also is the feed given first thing in the early morning when it is followed by another of sorghum straw. During the time when green grass can be collected in the fields, a considerable quantity is brought in to feed the bullocks and she-buffaloes at night. They are given also the stunted and damaged plants of cereals as the crops ripen. Altogether, from various sources, in an ordinary season, the ryot obtains a certain amount of green fodder during six months of the year for these two classes of stock.

But in Kurnool, every ryot endeavours to give his working cattle some artificial food also. From April to June, this is usually horse-gram (*Dolichos biflorus*), which is given at night after having been pounded and soaked in water. Later in the year, cotton seed is given, or, in places where that is not easily available, the grain of sorghum or of *korra*, the latter being given in addition to cotton seed in some cases. Cotton seed is always pounded and soaked and often greatly diluted with water; whilst, if horse-gram is not to be had in the hot weather, cotton seed is given in the form of a thin gruel and the coarser parts are

reserved for the buffaloes. The cattle of the richer ryots get these artificial foods all the year round, but those of the poorer only during the busy season. The allowance of horse-gram is about 3lbs. and of cotton seed about 6lbs. for a Nellore, and about half these amounts for a country-bred bullock or a young bull.

The working cattle and she-buffaloes are usually watered in the house, at least at night, and for this a trough is provided there into which all the water used for household purposes drains. At the bottom of the trough, the pounded cotton seed is placed, and the water used in washing grain before consumption is used to mix with it, any edible refuse being added and the whole mixed up together. The cattle, which only drink from the surface, are allowed first access, then the buffaloes, which bury their noses in the water and seek the coarser portions at the bottom.

It is perhaps natural that the ryot pays attention first to his tilling cattle, and that when fodder runs short they suffer least. In times of scarcity the ryot will try to keep his tilling cattle alive though the other stock may starve and die. Work cattle usually last from 8 to 10 years ; the local bred bullocks work at least two years longer than the Nellores. They are not shod for field work, but only when regularly employed on the 'made' roads, and it is not usual to pierce them for nose-ropes, although there is a Telugu saying that "a bullock without a nose-string and a child brought up by a widow are uncontrollable." Lameness is rare and cases of sore-neck are seldom seen.

The keeping of cows for breeding is governed chiefly by considerations of free grazing, and, speaking broadly, in the black cotton soil tracts of the district, cows are not kept except by wealthy men or Brahmins. Grazing of some sort is, however, fairly abundant in many parts of the district, and in these there are few ryots who do not own cows, whilst the wealth of some and of professional breeders in this respect is great. Ordinarily the ryots do not milk their cows, although the saying goes that "field produce is not as profitable as keeping milch cows," but value them solely for the calves they produce. But where large herds are

maintained, as by the Lambadies, during the rains when there is abundance of grass to encourage a free flow of milk, cows are milked once a day and ghee is made from the produce. Although the cow is valued for her offspring, little care is bestowed on her. Still less is given to the sire. Tradition says that at one time special bulls were kept for breeding, but now such bulls are to be found only with the owners of large herds. Among the Lambadies a wife brings, as her dower, a bull that remains as the lord of her husband's herd until a promising young bull dropped in the herd replaces him.

Cows and the young stock have to depend almost entirely on what they can pick up, although occasionally they may get a little refuse straw from the working cattle. All the cows of a village are usually grazed together in the "common field," or, during the cropping season, may be sent off to jungles to graze and are kept there. In these herds, there is always a number of young immature bulls, and the cows are mostly covered by these. From their earliest days, the calves go out to pasture with their dams, but are generally tied up at night. The cows yield but little milk, and the calves and heifers receive very little attention. Young bulls, when about three years old, are taken into the ryot's house and treated like the working cattle till they are emasculated and yoked. The Lambadies sell off their young bulls when about a year old, and thus only selected bulls are used by them as sires.

Heifers usually take the bull in their fourth year. The cows generally calve once in eighteen months. Most of the calves are dropped in May and June or in September and October, but there is no very clearly defined general breeding season. Little is done by the ryot to help the cows to rear good strong calves. The value of the cow-buffalo is shown in the saying "there will be no want in the house where the churn and the spinning wheel are at work." In Kurnool, milk-buffaloes are, after the tilling cattle, the most important—there are in the district even more she-buffaloes than breeding cows. They are almost all of one breed, a small black one, which

has a good local reputation for milk and butter. In selecting a milch-buffalo, the ryot looks for a dark skin, short legs, and thin thighs, and an udder which, with the teats soft and well set, is not itself soft and flabby; and the advice given is that you should "look at the mother before you marry the daughter, (and) milk a buffalo before you buy it."

The buffalo begins to breed after its third year and a good one drops a calf annually, the usual calving season being September. For three days after calving, these cows are tied up and allowed no green fodder, but are given warm gruel made from sorghum grain, with a little garlick added, and are washed daily with warm water. The whole of the first milk (colostrum) is not given to the calf, a portion being drawn, and for the first three days after birth, the calves are given a piece of cotton soaked in castor oil to suck. From the fourth day until they begin to eat grass, the calves are frequently given a few morgosa (*Melia Azardirachta*) seeds in butter to kill worms. They are very delicate and considerable numbers are lost during their first year, but afterwards they gradually become more and more hardy. They are usually kept tied up in the house until they are fully able to graze.

Cow-buffaloes, three days after calving, are put on a ration of about 4 or 5 lbs. of cotton seed, horse-gram, sorghum, or sazza. This ration is ground or pounded, soaked, and greatly diluted as already described. The concentrated food varies with what is available, and with it is given such green fodder as is procurable. If green fodder cannot be had, *korra* straw and *pottu* is given. Cotton seed is held to give the best quality and the largest amount of ghee, whilst though it is said that "the thicker the milk the more the butter," sorghum grain is held to produce thicker milk, but not so much ghee as cotton seed. Effect is given to the saying that "milch cows and children in arms need similar care."

Good cow-buffaloes will remain in milk for nine months after calving; for the first six months after calving they are milked twice daily, at morning and night, and it is only during the last three months that they are milked once a day. Two seers of milk

a day is held to be a fair yield. From this 15—22 tolas of butter are said to be obtained, whilst 32 tolas of butter give 22 tolas of ghee. The ghee is a perquisite of the women of the family; consequently "the milking capacity of a buffalo is only made known after her death" to her masterful owner.

It frequently happens that difficulties arise in milking cows that have lost their calves, because the saying is true that "unless the calf sucks, the cow will not let down her milk." Thus, the usual practice is to milk with the calf alongside its dam.

Dry and young buffaloes do not receive any special food, though they are housed at night and may get some straw then. The heifers are for the most part retained, but young bulls are sold off to drovers who take them into the districts to the south for use on 'wet' land. If it is found that a heifer does not take the bull properly, she is put to work until she does so. Special buffalo bulls for breeding are rarely found and no more care is exercised in this respect than in the case of neat cattle.

With regard to the epizootic diseases which attack his stock, the ryot, though in a general sort of way he likes the principles of segregation, an affected village being taboo, does not include prevention in his ideas. Within his village, the sick and the healthy live and graze together, and the carcasses of the beasts that die are thrown on some waste spot near the village, often near the wells or ravines draining into the principal source of water-supply, whilst the hides are secured by the chucklers as a perquisite.

THE UNITED STATES DEPARTMENT OF AGRICULTURE: ITS ORIGIN, GROWTH AND PRESENT CONDITIONS.

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The Indian Agricultural Department is but on the threshold of its existence. One is naturally inclined to speculate a little upon its future and to enquire what work it will be likely to perform, and to what extent it will be a real benefit to the agriculture of the country. If analogy be of any use under these circumstances, we have a very interesting example in the United States Agricultural Department.

In the space at my disposal I shall endeavour to show how this department was developed and also refer to some of the work accomplished. I am indebted chiefly for this information to a historical sketch compiled by Charles H. Greathouse. I have taken numerous quotations from his Bulletin. The sketch explains the objects of the Department and its organization and also describes its various divisions.

Previous to 1860, little attention was given to scientific agriculture in the United States. The patent office distributed seeds, and collected and published agricultural information. At this time the United States Agricultural Society was active in urging the establishment of a separate Department of Agriculture. In 1862 an Act was passed which provided for an independent department with a Commissioner at its head.

Washington really started the United States Agricultural Department and Franklin helped its progress by practical activity. The former proposed the formation of a branch of the National Government to care for the interest of farmers.

The Department as it is now constituted embraces many divisions, and its gradual growth is a most instructive study. The Weather Bureau took its origin from the observations of the Smithsonians, who devoted a great deal of time to the publication of Meteorological data. In 1872 the Government provided a Meteorological Department and the Department began to publish Agricultural Statistics. In 1863 the Department of Statistics was established. In 1904 a Bureau organization was provided.

During Commissioner Newton's time the Department Library and Museum were started. This Library was not officially recognised till 1871 when a librarian was appointed. The first books were obtained from the patent office. Additions have since been made by exchange and purchase. The Library now contains 92,000 volumes and is probably the best separate collection on agriculture and allied subjects in the world.

Although the Agricultural Department was separated from the patent office in 1862, it was not provided with separate buildings and other accommodation till 1867. It comprised at this time the Divisions of Chemistry, Gardens and Grounds, Entomology, Statistics and Botany. About this time the control of quarantine for animals was transferred from the Treasury to the Commissioner of Agriculture, and in 1884 the Bureau of Animal Industry was established by Act of Congress with a grant of $150,000 to deal with pleuro-pneumonia and other diseases.

The Hatch Bill became Law in 1887. It dealt with the form in which the results of experiments and investigations should be recorded, and for this purpose the office of experiment stations was established.

In 1889 the Department was raised to the first rank in the executive branch of the Government. Its work was "treated slightingly by many Congressmen, and was considered merely as a means to reach many constituents with small favours by the distribution of seeds and books. The clerkships and the positions in the Department were regarded as patronage to be given to political adherents, with little regard for fitness." "But Commissioner Le Duc, when appointed by President Hayes, took up the

duties with such earnestness that Congressmen were impressed with the seriousness of the work for which the Commissioner asked appropriations and the Department was granted more funds." "The head of the Department owing to persistent public opinion was given a place at the President's Council Table."

The Hon'ble Jeremiah M. Rusk was selected by President Harrison as his Secretary of Agriculture in 1889. In re-organising the Department he divided the work into two main classes: executive, under his own immediate charge, and scientific, under a specially appointed Assistant Secretary who had scientific agricultural attainments.

In 1893 the Hon'ble J. Sterling Morton became Secretary of Agriculture. He developed the Department considerably, and gave much time to the extension of publications and of the Library. He introduced farmers' bulletins. The Division of Statistics was developed. The Division of Agrostology and an agency to obtain new foreign plants from all parts of the world were formed. The Hand-book of grasses of the United States was published. The Weather Bureau was much extended, a cyclone service was established and exchange of data with other Governments arranged for. The Forestry Division made good progress.

Competitive examinations for service in the Agricultural Department were introduced.

Secretary Wilson took office in 1897. The Department has advanced extensively under his direction. The budget allotment for the Department in 1907 was $9,932,940 against $2,448,332 in 1897.

Since 1897 notable changes have been made in the work of the Department, particularly as regards enquiries into plant diseases, plant breeding, seed and plant testing and investigations regarding fruit growing. A Bureau of Forestry has also been established.

"Other branches of the Department which have been changed within the period indicated from a divisional to a Bureau organization with large increase of activities are the Bureau of

Chemistry, Bureau of Soils, Bureau of Entomology, Bureau of Statistics and Bureau of Biological Survey."

The Division of Foreign Markets was organized separately from the Division of Statistics in 1898 and a Solicitor for the Department was provided in 1905. Secretary Wilson has given much attention to the encouragement of home industries and sugar, silk and tea industries have thereby greatly benefited. "Agricultural explorations for discovering new crops, new varieties of old crops, new methods of cultivation and farm management, new species of desirable domestic animals, new modes of combating diseases of animals and plants and injurious insects, formed important features of the period from 1897—1905. Great progress has been made in the studies of plant breeding and soil investigation. Special attention has been paid to such points as food inspection, methods of storage for foreign markets, forest development and management, and a special point has been made of the encouragement of agricultural education by school garden work and prize competition."

One of the most important pieces of work done by the Department in recent years has been the establishment in 1903 of practical and direct relations between the Department and farmers' institutes through the appointment of a special agent of the office of Experiment Stations to co-operate with the State and County officials interested in this line of Agricultural Education. "Great advances have been made in the study of meteorological phenomena. Instruments and apparatus for recording weather data were improved and standardised and climatic statistics gathered, compared and used in making forecasts, then put in form for future use. The number of stations was increased, including points on the Caribbean Sea and the Gulf of Mexico, in Bermuda, the Bahamas and the Azores, until the real direction of important progress has changed from practical extension of this kind to a study of scientific problems, such as the study of the movements of the atmosphere at much higher altitudes than heretofore commonly reached. For this purpose the establishment of a great National Observatory for weather study has been

begun at Mount Weather, Virginia, a suitable point in the Blue Ridge Mountains, 50 miles from Washington. The watching of storms and floods was continued and efforts were made to render more efficient service to sea-faring interests and to farmers and business men in over-flowed districts. It has been impossible of course to prevent losses by floods, ice gorges and hurricanes, but the known saving effected has exceeded several times over the cost of the entire weather service."

"Crop reporting has been continued and improved and the issue of frost warnings extended. The function of the statistical service of the Department was clearly defined as the rendering of assistance to the farmer in receiving a fair price for his products. The reporting of crop prospects was improved and the spread of the information, when gathered, studied, and printed, was made more effective, especially by a system of posting card announcements of results in the 92,000 post offices of the country. The study of foreign markets was continued, and reports of trade relations with important nations, based on a study and analyses of Treasury reports of exports and imports, were published. *The Crop Reporter*, an eight-page quarto monthly paper, was established in 1899 as a means of communication between the Bureau and its thousands of correspondents. A special agent was maintained in London, chiefly for the purpose of reporting European crop conditions and prospects to this paper. Great progress has been made in the study of animal and plant diseases and likewise in Economic Entomology."

"The editing, illustrating and publication of results reached by the several branches of the service grew with the extension of the Department's activities. No effort has been spared to present facts of practical value in actual farming in terms perfectly plain to farmers of every position in life, so that all may receive the benefits paid for by all. At the same time statements of progress in scientific research have been issued in technical language in limited number for the benefit of persons associated more or less directly with Department scientists in their investigations. The illustration of these books was directed to making clear the

statements of the text. The Year-Book Series of the Department, which had recently been started when Mr. Wilson came into office, was continued and improved. It has received the commendation of American farmers and farm journals as well as European authorities. The distribution of Department publications to farmers constituted an important feature in connection with these publications. Press notices, lists of new and of all available publications were issued to keep the people informed as to what information and aid could be obtained. At the same time methods of keeping records of where valuable books have been sent, as well as of enquiry as to where they are needed, were combined to secure the greatest usefulness from these books to the farming world. The demand for these publications has so far exceeded the supply that it has been necessary practically to do away with all free distribution except to persons who contribute by service rendered to the Department work. Sales of them have increased notably in recent years. Special efforts by indexing were made to keep easily in reach of farmers and students such information as has been secured by the Department."

"The Library of the Department affords a means for the study by persons fitted for independent investigations of what has already been done in the leading Agricultural problems that is hardly equalled anywhere else in the world."

"The need of specially trained assistants in the Department work and the existence of unusual opportunities for study joined to make practicable a system of admission of young men and women into certain branches of Department work at low salaries with the purpose of continuing their studies along their chosen lines. From these student assistants, the Department has selected a number of capable officials whose service has justified the establishment of the system."

The investigation of the Cotton Bollworm weevil has resulted in the establishment of experimental farms in the cotton regions with the consequent wide introduction of improved and diversified farming.

Again, Congress, through the exertions of the Agricultural Department, has passed bills for the protection of game, and a special survey and study of birds and mammals is being conducted.

As mentioned above, the first special buildings for the Department were erected in 1867. In that year Congress appropriated $100,000 for the construction of an office building. This was ready for occupancy in 1868; about the same time houses for use in the propagation of plants for distribution were constructed along with conservatories and a grapery for testing foreign grapes. The total cost of these buildings was $140,000. In 1881 after the Atlanta Exposition, the Museum received so many additions that it was found necessary to provide more room. Accordingly $10,000 were appropriated for the construction of a building. Various other additional buildings were found necessary as the various sections of the Department increased, but up till 1897 not more than $210,000 had been spent on buildings. In order to keep pace with the rapid development of the various departments, buildings had to be constantly added from time to time till in 1903, Congress appropriated $1,500,000 for a magnificent building which provides accommodation for all sections of the Agricultural Department. This building is only now approaching completion.

During the last decade numerous experimental stations have been established all over the country as well as in Hawaii, Porto Rico and the Philippines.

So much for the development of Scientific Agriculture in the United States Department of Agriculture. Now, let us turn to the work which it has accomplished and analyse the value of the results obtained in comparison with its cost to the nation. The layman usually expects results in less time than is necessary for accurate investigation. Instances of this are common in India, and sceptical people in India should study American results. The American Agricultural Department has been in existence for nearly fifty years, and the list of work accomplished should influence the opinion of those who doubt the value of agricultural

science. I propose to mention briefly some of the more striking achievements.

"The Department up to May 1st, 1906, cost $60,110,836, or less than $1,500,000 a year. The chief question is what return did the nation get for its money. It is claimed that the Department has spread information which has enabled agriculturists, (I) to pay their taxes more easily, (II) to protect their property, (III) to largely increase the value of their property."

About the time the work of the Department began it was necessary to import large quantities of agricultural products. This was partly due to careless and ignorant methods of culture. Artificial fertilizers and even farm yard manure were little used and the rotation of crops was little practised.

Certain census figures indicate the increasing effectiveness of superior cultivation. In 1839 the production of corn (maize) was 23 bushels for each person in the United States; in 1899 it was 34 bushels. This does not, of course, show with certainty that there was a corresponding increase in the production for each acre cultivated, but a comparison of the crop of 1879 with that of 1889 justifies that inference. The comparison of the production of wheat gives a similar result. The quantity raised for each person in 1839 was 5·3 bushels; in 1890 it was 7·4 bushels.

It is impossible to estimate the monetary saving to the country of the work done, but the saving has been immense. The suppression of diseases of cattle and sheep has increased the foreign trade of the country enormously in exports of live animals and probably of tinned meats. The Division of Chemistry has shown the way to a large economical increase of production of cane sugar, and the introduction of the beet sugar industry is flourishing. I could point out many other agricultural investigations which have been profitable to the country. This is perhaps unnecessary, but I can say that investigation regarding plant breeding, injurious and beneficial insects and plant diseases have given results which are quite beyond calculation as regards profit to the country. The California Orange Industry was rescued from annihilation by the introduction from Australia of

the enemy of the Fluted Scale Insect; and the establishment of the Smyrna fig industry was rendered possible by the introduction and culture of the *Blastophaga* insect, whose activities are necessary to the production of the finest class of fig. The introduction of new varieties of crops and of new agricultural methods has in many cases been immensely successful.

Specific examples of money saved through the warnings of the Weather Bureau are numerous and easily established. Frequently throughout a year the services of the Weather Bureau cause savings in all sections of the country which are far in excess of annual expenditure.

I have only referred to a tithe of the advantages of the United States Department of Agriculture. It returns to the country full value for its cost.

DRY-LAND FARMING IN THE MADRAS PRESIDENCY.

By H. C. SAMPSON, B.Sc.,

Deputy Director of Agriculture, Madras.

Dry-land farming in the Madras Presidency offers great scope for investigation and improvement. In many districts such as Bellary, Cuddapah, Anantpur, Kurnool, Guntur and Nellore, the implements in use are admirably adapted for dry-land farming, but in the south, the plough and the land-hoe are the only common implements used for dry-lands.

Successful dry-land farming is intimately connected with the conservation of soil moisture, and the object of this article is to show how far this can be accomplished by judicious tillage under the conditions prevailing in the Madras Presidency. Before discussing the subject further it is necessary to explain the meaning of the term "soil moisture" as well as its sources and how it may be retained or lost. Soil moisture is the water which is held in the soil after the surplus has been allowed to drain away. This is necessary to dissolve the plant food which is in the soil and to convey it to the plant roots, but the surplus or drainage water is inimical to the healthy growth of plants as it prevents the aeration of the soil.

The sources of soil moisture are rain, subsoil water and atmospheric moisture.

Rain is the chief source, and it is of the greatest importance that the land should be prepared to receive it. A hard-baked surface cannot absorb much water; therefore, the surface should be loosened by tillage so that the rain can penetrate the soil. Subsoil water is another important source. Not only does the

subsoil relieve the soil of its surplus water, but it can replenish the soil moisture when helped by proper cultivation.

Besides these two main sources, the soil can by its hygroscopic properties, not only absorb moisture from the air, but can retain this in considerable quantities if a good tilth is secured. Thus, in parts of Madras the heavy dews which are experienced are of great value.

The retention of soil moisture can be assisted by surface cultivation which gives a loose surface soil or dry mulch. Deep cultivation and a firm soil will assist in keeping the soil particles together and thus cause a more even distribution of moisture through the soil.

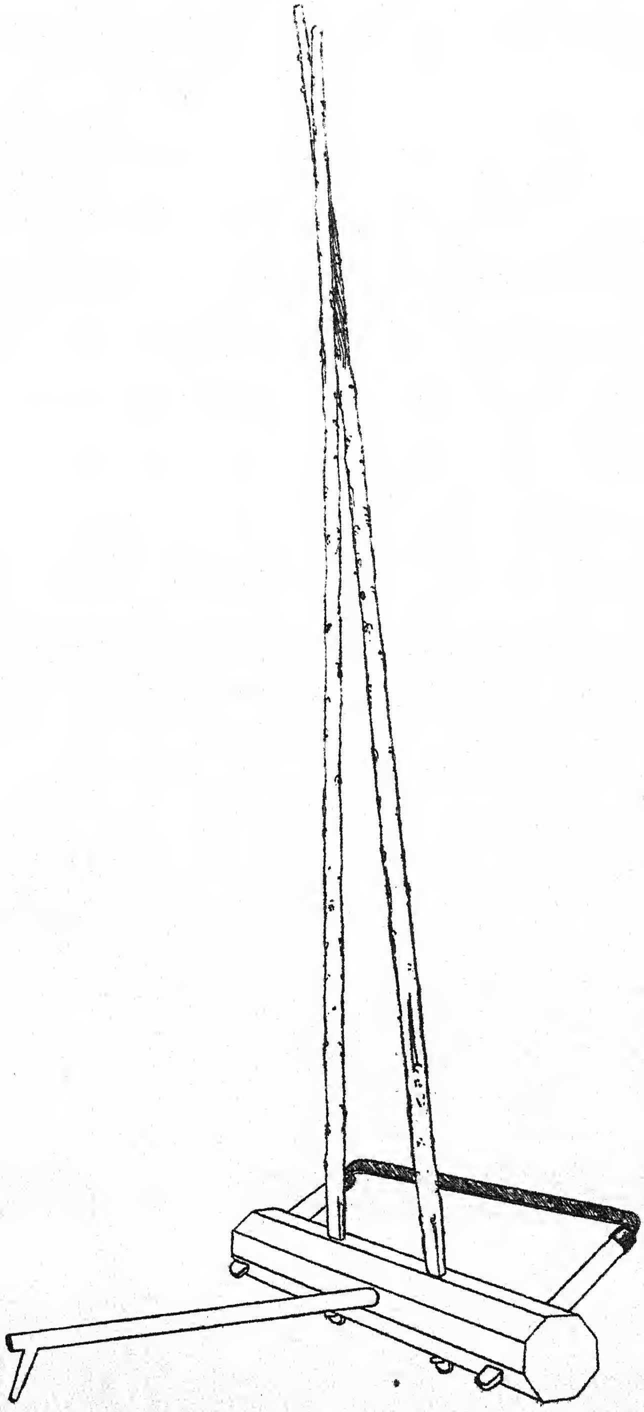
The following description will show how these principles are carried out in the dry-land cultivation of Madras. For this purpose the Presidency can be roughly divided into two tracts. In the former draught implements other than the plough are used and in the latter the plough is, as a rule, the only draught tillage implement.

The former includes the black cotton soils of Bellary, Cuddapah, Anantpur, Kurnool, Guntur and part of Nellore, as well as the lighter soils of these and of the Kistna district.

In the black cotton soil of this tract two types of plough are used. One, a heavy wooden plough which has now been largely superseded by a heavy iron one, and the other a much lighter wooden plough. The heavy plough is only used once every five or six years and is followed by a very heavy bullock hoe, known as a "Barra-Guntaka" which works to the same depth as the ploughing. What benefit is derived from this latter operation is difficult to see. The plough works the soil to a depth of a foot or more. Ploughing is done during the hot weather and huge dry clods of earth are poised up and beneficially exposed to the air. In other years either the light country plough or the bullock hoe called a *Guntaka* is used for preparatory cultivation. (Plate XVI.)

In the lighter soils of this tract this deep ploughing is not practised.

PLATE XVI.



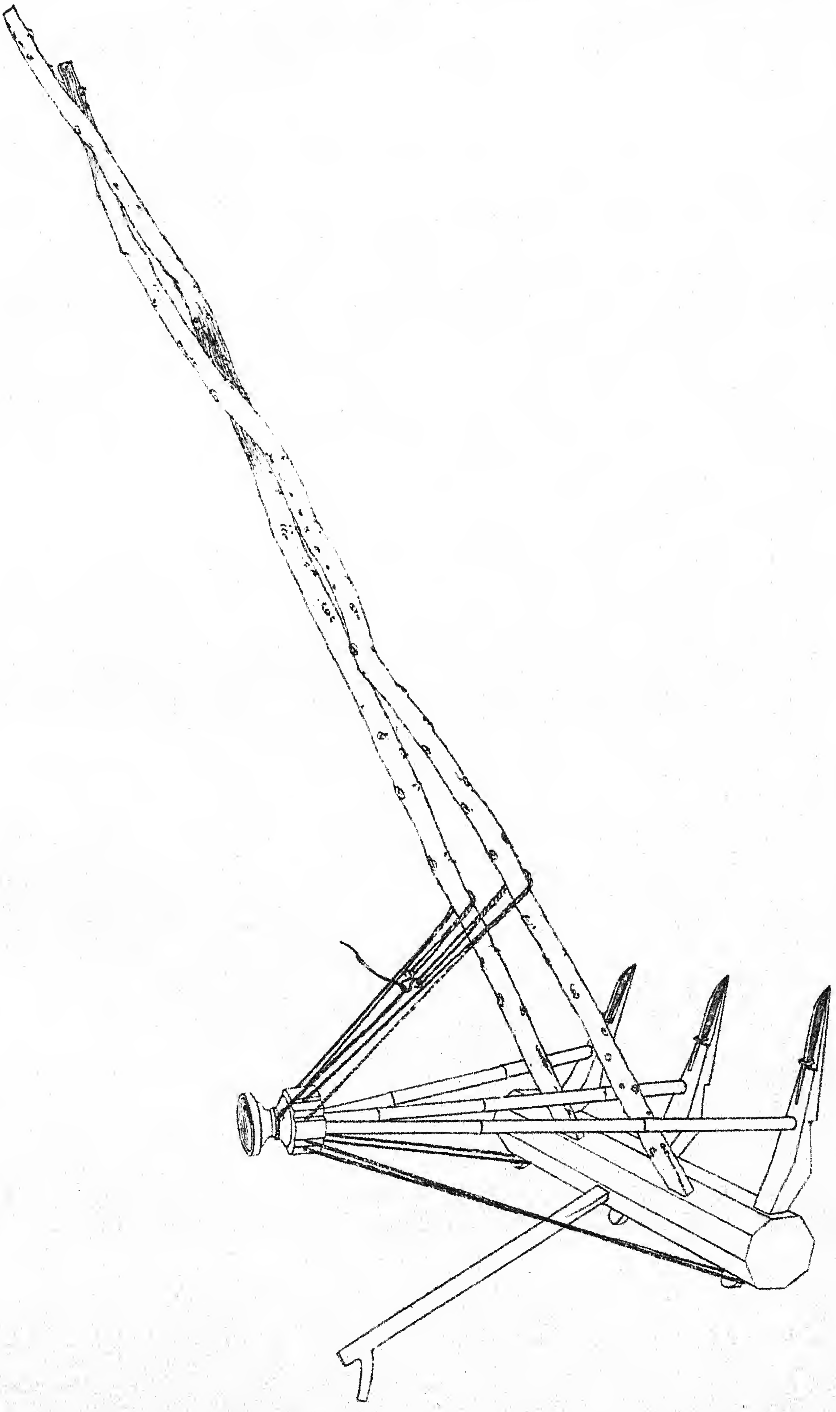
GUNTAKA OR BULLOCK HOE.

Preparation for Sowing.—This work is usually done with the bullock hoe or *Guntaka.* If worked after the land has been ploughed, it is a very useful implement. It makes a fine firm seed-bed and brings any larger clods of earth to the surface which are broken down by subsequent rains. The practice of working the soil with the *Guntaka* without previous ploughing is sometimes practised. This is objectionable as only the surface is loosened and the soil below remains hard set and lacks aeration. Occasionally, when the rains are very late, some such method of cultivation has to be resorted to, but the "Gorru" or seed drill without the bamboo sowing attachment is preferable to the *Guntaka.* (Plate XVII.) In some places this is weighted with stones and worked across the land in both directions and thus a large area can be worked in a day and often the ploughing rain can be utilised for sowing the crop.

Sowing.—The seed is sown with the drill. This practice has many advantages over broadcast sowing. It regulates the space for each plant. Sowing can be done when the land is comparatively dry as the drill can be set to sow at the depth where there is most moisture. Good germination is assured and there is a considerable saving of seed.

After cultivation.—Several implements are in use in different parts for this work, but the best are the *Dunthalu* which is used in the Bellary District and a small *Guntaka,* which is a similar implement with a wider blade and in the case of cotton and red gram is often used after the cereal catch crop has been reaped. The others work deep and throw the soil up round the plants forming ridges and furrows. The *Dunthalu* consists of a set of three to six small bullock hoes which are attached to a wide yoke pole and is drawn by two bullocks. (Plate XVIII.) Each hoe or *danthi* has an iron blade some 9 inches wide, which the driver guides between two rows of the crop. The hoeing is done after a good rain has fallen, but as a rule the farmer does not seem to realise that the operation is just as necessary when the surface has caked after a light rain, and in consequence, this implement is seldom worked more than two or three times.

PLATE XVII.



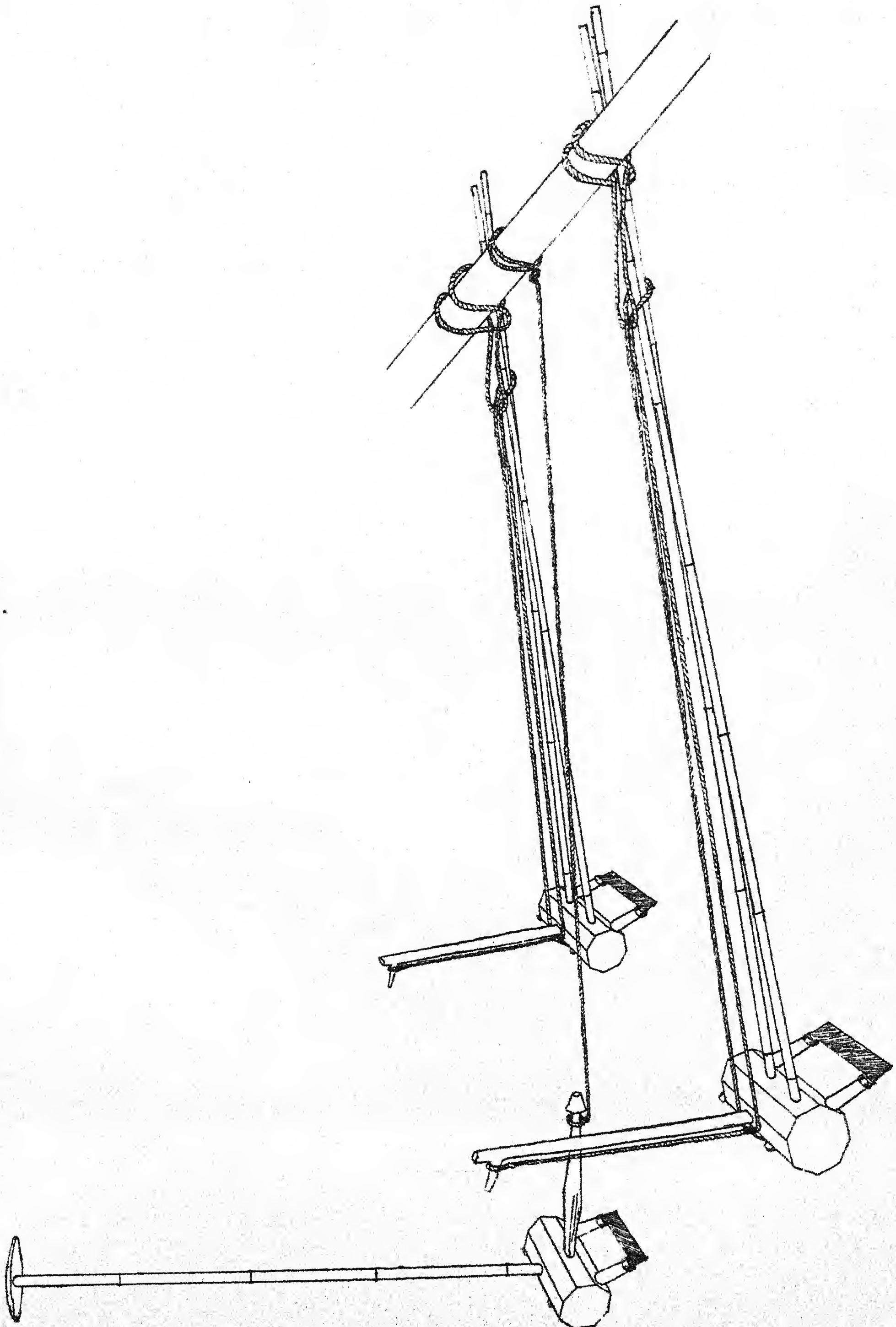
GORRU OR SEED DRILL.

A. J. I.

Throughout the Tamil country and in Malabar the plough is, with few exceptions, the only tillage implement for dry cultivation. In Malabar the conservation of soil moisture is not so essential owing to the heavy and continuous rainfall during the growing season. Ploughing commences with the close of the monsoon and is continued afterwards until the early sowing rains commence in April and May. In the dry Eastern Tamil country the rainfall is limited and does not admit of repeated ploughings before the sowing rains. The land is usually left untilled until a ploughing rain falls, when as large an area as possible is ploughed. About four ploughings are usually given. The ryot then waits for a sowing rain when the seed is sown broadcast and lightly ploughed in. The subordinate pulse crop, usually *Cajanus indicus* or *Dolichos lablab*, is sown immediately afterwards, the seed being dropped behind a light plough. In a few districts the value of a firm seed-bed is appreciated, and after sowing, the soil is made firm by dragging a roughly made brush harrow across the ploughing. In parts of Tinnevelly also the ryots cultivating red soil have an implement made like a large wooden rake which is used to break the surface crust and assist the growth of the young crop. When the crop is established, the plough is worked through it. This rough and ready method of cultivation gives a good crop in good seasons, but if the rain fails, the result is often a partial or complete failure.

In parts of South Arcot this practice of ploughing through the crop has been entirely given up in favour of the more efficient practice of hand hoeing. Here the dry cereal is considered as a catch crop for the groundnut crop, the seed of which is dibbled in after the cereal is well established. The land is often hoed two or three times. The first hoeing includes weeding and thinning, while the others are mainly for loosening the soil surface, and is done even if the land is perfectly free from weeds. The introduction of the harrow into the Tamil country would be an immense advantage. If used instead of the plough, the surface soil alone would be loosened and thus the soil moisture would be better conserved. The ground would be left level instead

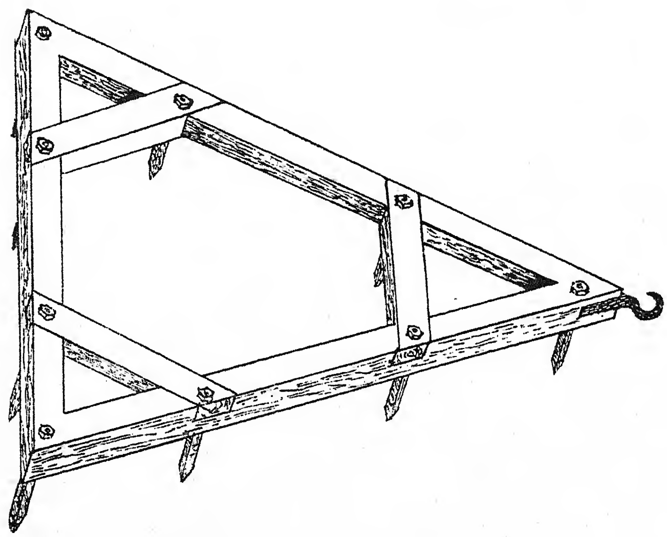
PLATE XVIII.



A. J. I.

DHUNTHALU.

of in ridges and furrows, which are always objectionable in the case of a dry crop as the ground soon dries out and subsequently rain runs down the furrows before it can soak in. If the harrow were used instead of the hand hoe, the cost of the work would be greatly reduced and the farmer would be able to



HARROW.

complete the work in less than a quarter of the time. The time that this operation takes is of great importance on the lighter soils. A harrow made in the shape of an equilateral triangle has been found to answer this purpose well and is not too expensive or too elaborate for the ordinary cultivator. This and other implements used in dry cultivation are illustrated.

THE AGRICULTURAL CONFERENCE AT AHMEDABAD IN NOVEMBER 1907.

By HAROLD H. MANN, D.Sc.,

Principal, Agricultural College, Poona.

PROVINCIAL Conferences in India for the discussion of agricultural matters are comparatively new and their utility is disputed. Many believe that they can serve no useful purpose and lead to little else than impracticable and irrelevant talk. The Ahmedabad Conference gave me an opportunity of judging whether such an opinion could usually be justified.

The Conference was presided over by the Senior Member of the Governor's Council in the Bombay Presidency (Mr. J. W. P. Muir-Mackenzie) and contained representatives from nearly every interest in the province which had even a remote connection with the culture of the land. It comprised merchants and millowners from Bombay and Ahmedabad, upon whom a large part of the cotton growers of Western India depend for their market; exporters of cotton or other produce whose agents penetrate into every corner of the province; landowners, large and small, from Gujerat, Kathiawar, the Deccan, and even from Kanara and the Southern Mahratta Country; representatives from local Agricultural Associations and genuine agriculturists—actual tillers of the soil. The agricultural needs of particular localities were clearly defined, and the discussions showed what were the real difficulties of the cultivators. They, moreover, indicated many lines in which the Department of Agriculture might be of direct and immediate use to the agricultural interest. I came away feeling that, for me at any rate, the Conference had furnished much food for reflection and basis for action.

In this article I shall merely discuss one or two matters that were brought before the Conference, and indicate some conclusions to which I have come, after a careful consideration of what passed there, combined with independent information. I am hopeful that such a statement will induce some of those who may not be in accord with my conclusions to indicate in a future number of the Journal their reasons for coming to a contrary opinion.

On the first day the very important discussion on the improvement of cotton completely overshadowed other proceedings. It was complained that the efforts of the Agricultural Department in this direction were painfully slow, and that little result had been obtained after a good many years of experiment. Doubt was expressed, moreover, as to the possibility of maintaining the purity and hence the quality of any new variety or type of seed that may be introduced. It was further stated that there had been great difficulty in getting manufacturers to give a fair price for small quantities of an improved staple, and that cultivators were, therefore, discouraged from growing new kinds. The manufacturers complained that they had no means of knowing where and when improved staples were being actually cultivated.

Round these points the whole discussion ranged. Mr. Gammie was able to give a complete answer to the complaint regarding the slowness in the production of improved types. In Bombay the false method of "field to field" selection was adopted and proved a failure many years ago. This might have been anticipated, since in many districts the best fields then contained, as they do now, a very complex mixture of different types of cotton, and these types themselves consist of good, bad and indifferent plants. Mr. Gammie stated that he had found it necessary, before even beginning the systematic selection and crossing of cottons on any large scale, to obtain, examine in detail, and define the very numerous varieties of cotton in the Bombay Presidency. This had taken years. Then selection and crossing were begun, and now there was a prospect that after next year some of the new varieties which have been

produced, could be distributed for experiment on a fairly large scale.

Neither Mr. Gammie nor any speaker at the Conference mentioned a difficulty which must follow as soon as improved stocks are brought into general use. This is the necessity for continuing the selection continually, for if this is not done, reversion to the average characters of the type from which they are produced will inevitably occur. Nearly all plants are apt to deteriorate in this country. An improved cotton hybrid will speedily degenerate unless its standard of quality and productiveness is maintained or improved by continual selection.

In other countries the difficulty is got over, in a measure, by the existence of professional seed growers, who are selectors-in-general to the community. A farmer may use his own seed repeatedly, but ultimately he goes elsewhere for it, and obtains it, directly or indirectly, from a special seed merchant. Here in India we have no professional seed growers on a large scale. For exotic crops the usual remedy is to import fresh seed at frequent intervals.

For indigenous crops which can be easily selected, like Jowar, the cultivators have, in many places, done the selection themselves. But for crops like cotton, where the seed cannot usually be imported every year, and where the selection, plant by plant, not only for staple, but also for percentage of lint, for weight of crop per plant, and so on, is difficult, selection is by no means generally carried out.

There are only two remedies, so far as I can see. One of these is to train cultivators in cotton seed selection by means of frequent short courses at the experimental farms, or similar short courses in their own villages; the other is for Provincial Governments either to organise seed farms themselves on a considerable scale, or give expert assistance to outside capitalists who may be induced to become seed growers on a commercial scale. The first method is admirable as far as it goes. I feel that too much cannot be made of its importance. But it is slow in action. It

is necessary not only to teach how to select but to make the cultivators realise the importance of selection.

A number of speakers at the Conference emphasised the fact that deterioration of cotton, due to admixture of varieties, was largely caused by the extension of steam ginning factories. The general opinion was that pure types of cotton could not be maintained in these districts, where mixed types are grown, if cultivators depended upon ginning factories for their seed. Steam gins are usually so arranged, that without very elaborate care it is practically impossible to give back unmixed to cultivators of small holdings their own seed. Large cultivators can arrange so that several gins and the adjoining floor space in a factory, can be cleaned out before their cotton is put in. Thus, there is a fair chance that they get back their own seed reasonably pure. There was a decided feeling at the Conference that it would be well for the cotton industry of any district if we could get back to the system of hand ginning which has almost entirely died out, or failing this, if pure types of cotton were ginned under the direct supervision of officers of the Agricultural Department, or by genuine seed merchants.

It seems necessary, therefore, that a system of seed growing and ginning for sale must be part of the organisation of the cotton industry if real improvement is to take place. The same reasoning applies equally to any other agricultural crop in which selection cannot be made with considerable ease. In this article it is out of place for me to describe fully the requirements for seed growing, but alternative methods might be suggested as follows :—

(I.)—Should Government initiate large seed farms?

(II.)—Should selected cultivators be subsidized and their work controlled or guided by trained men of the Agricultural Department?

(III.)—Can outside capitalists be induced to take over such large seed farms as are initiated by Government and extend them as a specialized Indian industry? These suggestions demand careful

consideration, and a criticism by practical men of their advantages or disadvantages would doubtless be welcomed by the Agricultural Department.

There was a good deal of animated discussion at the Conference as to the means of securing a fair price for improved cottons. Many of these better types are recognised as being more difficult to grow : a longer staple usually means a longer growing season : often the percentage of lint to seed is lower : and it is only if the cotton obtains a distinctly higher price in the market that it will pay to grow the better variety. On the other hand, it was urged on behalf of the manufacturers that small quantities, though recognised as being superior, were no use to them. Unless at least five bales* are marketed together, they could not give a better price. Now, five bales of cotton are usually beyond a single cultivator's power to produce. So that till a considerable area is under an improved cotton, no better price is obtainable. The difficulty is considerable. The cultivator says : " Unless you give me a better price for my lint, I cannot grow the improved cotton." The manufacturer replies : " Unless you give me at least five bales, I cannot give a better price."

This difficulty has been got over in the case of Egyptian cotton in Sind, by the establishment of a public auction at Mirpurkhas, where all the small quantities of cotton can be auctioned together. The extension of this method in other parts where improved cottons are introduced, is one way out of the difficulty, if it is found feasible. Otherwise the only method seems to be for Government or others to arrange temporarily for combined marketing. It was also suggested that a fund should be raised by the trade, to be aided from the money placed in the hands of the Government by the British Cotton Growing Association, to be given as a bonus to cultivators growing improved cotton. This might be possible, but I am not very sanguine.

* This amount was mentioned as their minimum by the millowners of Ahmedabad.

Another proposal came from the millowners of Ahmedabad, that a sample room (which they were willing to provide) should be opened at Ahmedabad where all the improved cottons could be on view, and data given as to where they were being grown. If this information was in their hands, they could send their agents to the places where the cotton was being grown, and purchase various lots themselves on the spot. The suggestion appears to be a very practical one. The required samples should consist of at least ten pounds of cotton lint, and be renewed as needed, and should be freely open to public inspection. If such a sample room were opened, and well managed, it would at least enable buyers to collect from the growers a sufficient quantity for practical trade trials.

Such are the principal points of the discussion on the improvement of cotton. The questions of the maintenance of an improved stock, of the prevention of mixture with inferior varieties at the gins, and of the marketing of small quantities of improved cotton, seem to have been perhaps those of the first importance. Whether any of the suggestions I have recapitulated or made are sufficient to deal with these undoubted difficulties can only be decided in the future. But they certainly give a basis for action, and action of some kind will certainly be necessary, by one or more of the parties concerned, if these very real difficulties are to be solved.

Just as the question of the improvement of cotton was the chief matter for discussion on the first day at the Ahmedabad Conference, so on the second day the most interesting and profitable time was given to the question of the functions and best method of the working of agricultural associations.

It may be well to preface an account of the principal points in the discussion by saying that there are not as yet any number of such associations in the Bombay Presidency. Three district agricultural associations exist at present. These are at Ahmedabad, Dharwar, and Broach, and there are a number of smaller associations organised in talukas in Gujerat and the Deccan. But, generally speaking, the idea has not yet taken

root, and the work which the associations are to do, when formed, has not hitherto been very clearly understood or defined.

In attempting to consider, in the light of what was said at Ahmedabad, the probable line of most useful development of what I may call co-operative associations for the improvement of agricultural methods and practices, it was striking to observe how unanimous the speakers were as to the necessity of building up from the smaller units to the greater, that is to say, from the village association (where possible) to that of the taluka, and from the latter to one extending its services to the whole of a district. This position was stated by men from Gujerat, from the Deccan, and from the south of the Presidency. The opinion was, in fact, the echo of what has been found in almost all, if not in all, efforts of every kind to benefit agriculturists everywhere, including co-operative banking.. In respect to the latter, the most recent writer says :—"Organise downwards from the top, and in such matters, you are bound to fail. Organise upwards from below, and, if only you are judicious in your measures, you will succeed." I am confident that this is the right method, and that the attempt to form a central agricultural association, whose existence shall afterwards induce the formation of smaller local and village associations, is usually bound to fail.

Several speakers insisted on the necessity of not pressing the formation of local associations with any semblance of a Government order. If local ideas are largely influenced by official opinion, we may have again, at once, all the evil effect of building from above. A body of men who unite for any purpose by instruction, or even apparently by instruction, from a superior authority, will also limit their activity to the further instruction received. I am confident again that the speakers were right in this matter, and that, unless the people feel it is a co-operative and not an official effect, little or no development of useful functions will take place. In this connection, as a result of a conversation I had with the representatives of existing associations, I would be inclined to doubt whether the regular appointment of a Government officer,

especially a revenue officer, as chairman, is wise if the organisation is to succeed. It is all a question of personality. In some cases the Mamlatdar in the case of the smaller bodies, or the collector in the case of the larger, will be naturally the leader: in others he will always be suspected, and the association will be still-born. I am aware that the appointment of these men as officers to correspond with the Department of Agriculture is usually very advantageous. They are accustomed to such correspondence, and their representations are more easily understood and perhaps carry more weight. But if we really mean the local associations to fulfil their primary purpose in improving the agriculture of the villages, this advantage must, where necessary, be at least partly sacrificed.

A suggestion was made at the Conference that, where such still existed, the village organisation should itself become the agricultural association. No new name would be imposed, no sense of strangeness would be felt, only that this organisation would be asked to fulfil some extra purposes. "That would be a more natural procedure to adopt," said Mr. Wood, "than to create some new bodies, impose upon them occidental names, and put before them long sheets of printed bye-laws." The idea seems an admirable one, but in any case, as is at once obvious, "the long sheets of printed bye-laws" would be fatal to an agricultural association or to anything else in Indian village life. There seems a good deal to be said for the suggestion, also made at the Conference, to let the formation of agricultural associations follow the introduction of co-operative credit societies. The latter introduce the idea of co-operation under a regular inspection, and once such a society is successful in a place, the people will be ready for a further development of the idea. This has been even more recently emphasised by Mr. Stanley Reed of Bombay in a paper read at the Indian Industrial Conference at Surat. He said:—"At a recent conference at Ahmedabad a decided preference was expressed for village, or at most taluka, associations. I would only say that this is one of those questions in which it is desirable to hasten slowly, and if it be agreed that a

start should be made with village societies, those villages should be selected where the co-operative credit movement has taken the firmest root."

Regarding the organisation of agricultural associations, we have, then, in summary the following points :—

(1) The unit of organisation should be as small as possible, a village by preference, but where this is impossible, a taluka.

(2) The organisation should not be forced, and should have as little as possible of the Government order about it.

(3) While officially patronised, its organisation should be essentially popular and co-operative.

(4) Existing village organisations should be used, wherever possible, rather than have the introduction of a new body with a new name.

(5) Co-operative credit societies, firmly rooted, are the best introduction to an agricultural association.

Turning now from the organisation to the functions of an agricultural association, it was universally recognised at Ahmedabad that they must be solely agricultural if they are to do their best work. The improvement of agricultural methods was seen to be as much as an association was capable of dealing with. And if this be the case, perhaps the most important function of the local organisation is to keep the central body, which stands for the improvement of agriculture in the whole province, *i.e.*, the Department of Agriculture, in touch with the actual cultivators in the field. Here has been the weak point hitherto in the agricultural organisation of many Indian provinces, if not in most. One of the speakers particularly emphasised the present lack of touch, in Gujerat at any rate, between the Agricultural Department and the agriculturists. And the local agricultural association must be the link, if any is to exist.

But here a difficulty arises. If the local organisations are to be small, as already recommended, the touch cannot be maintained by correspondence : it must be by the personal and frequent presence of thoroughly sympathetic officers of the Department, who are themselves practical agriculturists. If

correspondence can be fully replaced by personal presence, then I shall have better confidence in the success of agricultural associations as a means of agricultural development. The men who can do it must be sons of the soil, be well educated in the science and practice of agriculture and be otherwise well chosen: the areas they have to cover must be comparatively small; they must be very keen on their work. Such men already exist in Bombay, and more will be produced when the Agricultural College at Poona is thoroughly established. Divisional Inspectors of the class above described will have, as part of their duties, the function of bringing the local associations into regular touch with the Department. But ultimately more men than these will be required if the movement is to be a thorough success.

Such a man, as I have described, as the adviser of the local people, will, if he is the proper man for the work, give just the impetus which is required to make a village or taluka association an actually working body. And with this impetus, the next step is to the organisation of agricultural shows and demonstrations of clearly known improvements. These two things should go hand in hand. The demonstrations, if successful, as they must be, would probably be an integral part of the local show. Adequate prizes could be arranged for produce, for standing crops and for animals, and so give a spirit of emulation among the people. The special officer of the Department, whom I have described, must be present, and demonstrate the demonstrations, if I may be excused the term. Further, he must carry from show to show some machine, within the capacity of a cultivator or a village association, which would, from his own personal and intimate knowledge, be an improvement on the system in vogue on that countryside. These shows would be very local, the more local the better in many respects. They would themselves do good as shows, but they would be even better as a means of bringing actual improvements to the door and notice of the cultivators. They would not replace the larger and more elaborate shows at important centres, but they would have a function, an important function. Of them the local

agricultural association is, however, as it were, the foundation-stone.

A good many speakers at the Conference emphasised the importance of short courses in specific improvements which should be given at the experimental farms or elsewhere. It would be probably impossible to arrange for these directly in connection with smaller associations, but these latter could and would select the men who would be most likely to profit by them, and send them to a centre for the purpose.

Beyond this such local associations have a large number of useful functions, many of which were indicated at Ahmedabad. They give (generally through the Divisional Inspector or the more numerous men who will replace him) intimation of a plant disease or an insect pest, and indicate that they want help. They select the best men to whom new seed, new manures, and new implements are sent for demonstration. They report difficulties through deterioration of land, which can then be closely investigated. They are the body to whom agricultural information is sent, whether published in the form of vernacular leaflets or through the vernacular press. And, in general, they form, as I have said above, the link between the Department and the people.

This, on the whole, is how I interpret the trend and meaning of the opinions expressed at the Ahmedabad Conference. There was much enthusiasm, an enthusiasm which should, I think, be utilised. Many of the suggestions demand much elaboration and modification at the hand of the man who carries them out. The key, however, to the rapid progress of agricultural improvement in the Bombay Presidency lies, I was made to feel at the Conference, in the development of co-operative agricultural associations, together with the getting together of a body of advisers who can go from place to place, are thoroughly imbued with a belief in agricultural development, and are keen agriculturists themselves. The whole of this must be backed (and I think that fact is already realised) by consistent and constant scientific investigation into the difficulties, as they arise.

In the present paper I have only indicated, and more or less inadequately discussed, the two principal questions which formed the programme at the Ahmedabad Conference. Other important matters were raised, but their consideration was not thorough enough to make it profitable to summarise the ideas that were expressed. Their discussion on a more satisfactory basis will, no doubt, be taken up again at one of the future Conferences.

NOTE ON AGRICULTURE IN JAPAN.*

By SIR F. A. NICHOLSON, K.C.I.E., I.C.S. *(Retired).*

[REVIEWED BY E. SHEARER, M.A., B.SC.,

Imperial Agriculturist, Pusa.]

In this Note, which has resulted from an extensive tour in Japan, undertaken primarily to study fisheries, we are presented with facts and figures in relation to Japanese Agriculture which, to use the author's expression, *command* attention. "The gross area of Japan proper is 94,000,000 acres. Of this the greater part is mountainous and hilly, and in the north endures a long winter. . . . . With all the labour industriously applied during thousands of years only 12,778,124 acres or 13·53 per cent. of this area was arable land under cultivation in 1905. The rest is not at present cultivated, and by far the greater area never can be. . . . . . The crops on this small area *plus* fish from the sea and some poultry and eggs, practically feed the whole Japanese nation, for meat, milk, butter and cheese are not articles of their diet; . . . . The average annual net imports from 1895—1905 would not feed the country for two weeks. The population in 1905 was 47,812,702, so that it subsists on an area of 0·267 acres per head, an area which, for a self-sustained nation, is probably of unparalleled minuteness. . . . . . Yet the Japanese are the reverse of starved; they are particularly strong, sturdy and well-nourished; beggary is hardly existent and emaciation not visible." When we consider in addition that even the arable area of Japan is, according to many presumably competent observers, naturally of low fertility, that it "has paid very high rentals to a non-labouring or leisured class, has kept its soils not only unexhausted but fertile, and has done all this without imported food or manure, almost without cattle, and wholly without any manurial or

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'artificial' fertilisers even from within its own borders," the importance of a study of the Agriculture of Japan will be admitted. Japan is essentially a country of small cultivators. "In 1901 farms below 2 acres formed 55 per cent. of the whole number, those between 2 and $3\frac{3}{4}$ acres were 30 per cent. and those above $3\frac{3}{4}$ acres were 15 per cent. . . . . The average occupancy for the country is only 2·55 acres." About two-thirds of the occupants are tenants or part tenants, the remaining third peasant proprietors. Taking state assessment and local rates together, rural land bears an average annual assessment of Rs. 9-3 per acre. Since the Russo-Japanese war this has been increased by 60 per cent., temporarily it is true, but with little hope of its ever falling to its old level. In addition, two-thirds of the farmers pay rents for their lands, which, as is commonly the case in countries of small cultivators, are often rack-rents. As in India, the farms are made up of scattered fields, but a measure recently passed to encourage consolidation of holdings, is being largely taken advantage of, the Agricultural Associations playing an important part in the necessary work of arbitration and exchange.

In Japan, with the exception of the north, the conditions of temperature and rainfall are almost ideal for the growing of crops, as will be seen from the subjoined table.

Average rainfall and average mean temperature in Tokyo by months for the period 1875—1902.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
Rainfall in inches.	2·18	2·92	4·36	5·16	6·12	6·68	5·28	4·64	8·20	7·28	4·36	2·24	59·42
Mean temperature in Degrees (Fahrenheit).	36·86	38·48	44·42	54·32	61·88	68·72	82·58	85·82	71·60	60·44	50·18	41·36	...

The country, moreover, everywhere abounds in streams and springs fed from the mountains and hills of the interior. But if

climatic conditions are favourable, Japanese agricultural practice is such as to take full advantage of them. "There is *no* slovenly cultivation, no carelessly worked areas: all seems on a general level of excellence and is like one vast, well-worked garden. The soil generally of dark loam, is absolutely clean; weeds are not to be seen at any time among the crops: all stones are removed so that every square inch may play its part." Tillage is carried on almost entirely without the aid of cattle or other draught animals which are only now slowly being introduced into a few districts. Before sowing, a perfect tilth is obtained on every field by continued digging, and while the crops are growing, there is constant interstitial digging or hoeing up to the time of harvest. A striking feature of the tillage is the ridge and furrow system, which is universal on the uplands. When a field is ready for a crop, the seed is carefully sown in lines, some two feet apart, and as the crop grows, the lines are gradually earthed up from each side, so that eventually ridges and furrows are formed. The furrows are kept constantly stirred and cleaned, and when one crop is approaching maturity, something else is sown in them, and this in turn, when the first crop is removed, is gradually earthed up, ridge and furrow changing places. "It is claimed for the system that it permits or rather compels deep cultivation with complete aeration and commingling of the soil, that it is economical of seed; it allows free tillering and full development of the plant owing to free ventilation and sunlight and to the supply of fresh earth not only in the deep seed-bed but by the frequent earthings up; it permits the planting of one crop while another is growing; but its chief merits seem to be that it permits easy and thorough tillage during crop, the absolute removal of all weeds, the formation by tillage of that mulch of fine earth so essential for maintaining moisture in the undersoil, the easy watching of every plant in the crop, and the ready application of small doses of liquid manure whenever necessary."

But that which most impresses an observer, familiar with Indian conditions, is Japanese manurial practice. As there are only a little over 1,000,000 each of cattle and horses in Japan, and

sheep and goats are practically non-existent, the manure supplied by live stock is altogether an insignificant quantity. The great source of manure is human excrement or night-soil, and the care exercised on the collection, preparation, conservation and application of this excellent manure is extraordinary. Whether in town or country none of it is lost to the land. All is carefully collected and stored at the homesteads or in the fields in vats with closely thatched roofs, which not only protect the contents from sun and rain but prevent over-free circulation of air and consequent loss of ammonia. Night-soil is never applied fresh to the land. After fermenting in the vats for not less than ten days, it is found to be converted into a semi-fluid mass and is considered ready for use. It is applied to crops diluted with water from one to ten times its own bulk, the first dose on the spots where the seeds are to be sown or seedlings planted, while subsequent doses are given to each plant as required, the last at the time when the plant is coming into flower. No crop is grown without manure, and every plant or group of plants receives its specific dose, not only once, but several times during the growing season. It will be conceded that such a system of conservation and application, exceedingly laborious as it is, involves a minimum of waste. The total value of the night-soil thus saved in Japan, after allowing for inevitable loss and wastage of all sorts, is estimated to be, in terms of units of nitrogen, potash and phosphoric acid, at current rates, not less than about Rs. 800 lakhs per annum, and in terms of increased produce resulting from its application, it must be a great deal more.

Equal care is bestowed on the preparation of compost. It is " absolutely universal as a manure ; it is the solid or dry complement of the equally universal liquid X (night-soil) and is a practical illustration of the 'waste nothing' principle of Japanese farming. Every scrap of organic matter is carefully searched out and collected, animal excreta, always excluding human, but including those of fowls and of pigeons which are often kept for the purpose, leaves, weeds, straw and all sorts of vegetable refuse from the town, farm or house, such as potato peelings, radish tops

and so forth, dead silkworms and their pupæ, slaked lime and shells, bones of all sorts pounded small, wood and straw ashes, indigo refuse, astragalus grown after a paddy crop, loamy earth, etc., are all pressed into service. These materials are piled up in the yard or under a shed; usually a layer of vegetable matter first, then animal dung, then lime, powdered shells and wood ashes; the mass is then moistened with the liquid drainings from the stables, if any, or more generally with human urine, covered with earth and allowed to ferment together in a mass which is usually sheltered from the rain by stout straw mats if not under a shed. The mass is occasionally turned over, and is left until the whole has decomposed into a fine rich nutrient earth (the Japanese name is 'manurial earth') which is passed through a sieve and used as a fine powder, especially at sowing time; the coarse matter which does not pass the sieve forms part of the next heap. Occasionally it is said that the mass is burnt, the resulting black earth being used in the same way."

Fish manure has long been appreciated in Japan. The quantity manufactured in 1904 was 133,600 tons, the value of which, calculated on the same basis as night-soil, would be over Rs. 100 lakhs. Of late years, on account of the increasing demand for fresh fish, especially in the towns, the quantity available for fertiliser has gradually been diminishing, while the price of fish manure has more than doubled. Government is, however, fully alive to the importance of fish as a source of food-supply and manure, and strenuous efforts are being made to develop the fisheries.

Oil-cake is another important fertiliser in universal use. Not only is there no export of oil-seeds or cake, but there is a large import of cake from China amounting in 1903 to 212,000 tons, costing about Rs. 75 per ton, and the imports are steadily going up.

Green manuring has within the last twenty years become a regular practice, chiefly on rice lands. Just before the paddy is harvested, seeds of *astragalus lotoides* or *sinicus*, a papilionaceous plant, are broadcasted on the land. After the paddy is removed,

the astragalus grows rapidly without any further cultivation, and in May is either turned in where it stands or more commonly cut, and carried to other fields or the compost heap.

Heavy crop returns are the natural corollary of favourable climate, thorough tillage, and sound manurial practice, but in Japan the yields are even heavier than we expect. Thus in the case of paddy, which occupies annually more than half the total arable area, the normal yield, for the whole country, is over 30 maunds per acre of unhusked rice. In some provinces the average is said to be over 40 maunds, while yields of from 50 to 60 maunds are said to be not unknown. Sugarcane, which is grown on a comparatively small area, is said to give an average yield of 8 tons of *sugar* per acre, an enormous figure. It is difficult to get at the yields of the millets, pulses and cold weather cereals, because of the almost universal practice of growing these crops mixed, but some idea of the general productiveness of the soil may be gathered from the fact that with prices not varying much from those ordinarily prevalent in India, the average value of agricultural produce for the whole country was in 1902 Rs. 123 per acre.

The forests of Japan play an important part in agricultural economy. Out of a total area of 52·5 million acres of forest, 18·5 million acres are "private" forests, belonging either to private individuals or the village communes, and held in 21 million plots, so that each plot averages 0·88 acre. They are thus the wooded plots attached to the various holdings, sometimes intermingled with the cultivated fields, sometimes distant and forming continuous woods. They provide not only the firewood and timber required for domestic purposes, but are also largely drawn upon for material for compost heaps and green manuring. Scientific sylviculture has in the past been little understood, and the timber produced has been relatively low in quantity; but in this, as in other respects, the Japanese have shown themselves progressive, and under the stimulus of Government a new era of forest management has been entered upon.

Nothing better illustrates the thoroughness which is characteristic of the Japanese nation than the manner in which the

Government has initiated, developed and organised, agricultural education and research, and the response of the people to the lead of Government. Sir Frederic Nicholson estimates the total expenditure, Imperial and Local, on agriculture and agricultural education at not less than Rs. 80 lakhs per annum. Agricultural education begins in the higher elementary schools, in a large number of which the pupils are taught Agriculture and Natural Science. *All* teachers in Japan receive instruction in these subjects at the normal training schools. In close connection with the elementary schools are 1,436 supplementary schools which give more extended instruction in agriculture. These are either evening schools, or give short courses in the winter months or during slack seasons, and are largely attended. Next come 118 regular agricultural schools of two grades. In the lower grade schools, of which the pupils must be over 12 years of age, there is a three years' course with 27 hours of study per week, exclusive of practical work. In the higher grade schools, the pupils must be over 14 years of age, the course is more advanced, and extends over three or four years with a two years' post-graduate course, if desired, for specialisation in particular subjects. To both these classes of schools are attached experimental and demonstration farms, which serve for the instruction not only of the pupils, but also of the agricultural population in their neighbourhood. The teachers, too, regularly deliver lectures on agricultural subjects to farmers at various centres. Both the agricultural schools proper, and the supplementary schools from which they often develop, are of local origin and are supported by local funds aided by moderate Imperial grants. Nearly all the pupils which pass through them either return to the land, or become teachers or agricultural officials. Finally, there is the Agricultural College of Tokyo and the Colleges at Sapporo and Morioka, with fully equipped laboratories and experimental farms, where agricultural experts, teachers, and agricultural officials, are trained. The work of the schools and colleges is largely supplemented by the experiment stations, one large central station with several branches, and numerous local stations. The latter

cost about Rs. 6 lakhs per annum, 75 per cent. of which is met from local funds. In connection with the experiment stations, there are no less than 300 itinerant lecturers, who give instruction in agriculture and allied subjects.

In close touch with the experiment stations are the Agricultural Associations. Probably in no other country are these so general and so well organised as in Japan. They are divided into Prefectural, County, and Village Associations, "of which there were recently 46, 579 and 11,968, respectively, as compared with 47 prefectures, 638 counties and 13,509 towns and villages." Taking the Village Associations first, "before any Village Association can be formed not less than two-thirds of the persons qualified shall consent, provided that such two-thirds own not less than two-thirds of the cultivable land; but when such association shall have been formed, *all* persons qualified for membership must join it." The funds of the association are derived from the subscriptions of the members. Each Village Association within a county elects a deputy, and these deputies together constitute the County Association. The Prefectural Association is similarly made up of deputies elected by County Associations. Finally, the Prefectural Associations elect deputies who together form a kind of Central Agricultural Council.

The work undertaken by the Village Associations is extensive. They are responsible for reporting to Government on the agricultural conditions of their areas, and for furnishing agricultural statistics. They undertake seed selection and distribution, establish common seed-beds for the members, combine for the destruction of insect and other pests, initiate agricultural experiments and introduce agricultural improvements, purchase manures wholesale for the members, conduct competitive exhibitions of agricultural products and implements and of growing crops and award prizes or honours, give assistance in sericulture and other home industries, make provision for agricultural education in schools, or, by lectures, assist in the consolidation of fields, publish bulletins, and, in various other ways, promote the interests of the members. The County Associations assist and to a

certain extent guide the Village Associations, while the Prefectural Associations stand in a similar relation to the County Associations.

Such, in brief, is the position of agriculture in Japan. If we compare the agriculture of Japan with that of India, we have, of course, to deal with conditions, which, in many respects, are widely different in the two countries. Thus, there can be no doubt that Japan owes much of its prosperity to its wonderful climate. No country can better than India appreciate the advantages of a rainfall, which, while assured, plentiful, and well distributed, is seldom excessive. In India, when the season is really favourable, surprisingly good crops are to be found even in districts where the land commonly grows two crops a year, is indifferently tilled and receives little or no manure. Crop yields in tracts which are independent of rainfall, through being commanded by irrigation, compare not unfavourably with those of Japan. Again, practical certainty of good crops, if it sometimes encourages carelessness and laziness, equally often serves as an incentive to good husbandry. On the other hand, the soil of Japan is probably naturally less fertile than that of large tracts of India, the holdings are smaller, and, on an average, probably pay more in the shape of assessment and rent than is common in India. But granting these differences in conditions, there is much that the Indian ryot can learn from the Japanese peasant. We have described the thorough character of the tillage universal in Japan. The methods in detail are mostly unsuited to Indian conditions. To perform all the processes of cultivation with spade and hand hoe is only possible on very small holdings, and can give a return commensurate with the labour employed only where conditions ensure a high yield per acre. The ridge and furrow system is employed with advantage in "garden" cultivation, but for climatic as well as other reasons could not be generally adopted. But what we can aim at in India, as in Japan, is that the tillage should be the best possible under the circumstances. In India there is much good cultivation and much bad. If the methods in use in the best cultivated tracts

could be made more general over the country, a great step forward would have been taken. The system of drilling seed and giving subsequent interculture of crops by bullock hoes, which is the common practice over large tracts of the Central Provinces and Bombay Presidency, and in Gujerat especially, has reached a high pitch of excellence, is capable of great extension. It is economical of seed, ensures a better distribution of plants on the ground and saves time and labour, both at the time of sowing and in the after-cultivation of the crops. The cost of drills and hoes is nominal.

Many large iron ploughs are in use in the black cotton tracts of Madras, Bombay and the Central Provinces. They do excellent work in these heavy soils, but are too heavy for the cattle of the average small cultivator, and in any case are beyond his means. There is, however, room for a more extended use of the lighter patterns of improved plough. They are moderate in cost, and while they cannot entirely replace the indigenous wooden plough, for breaking up and pulverising the soil, they are in point of time and labour much more efficient than the latter.

But it is as regards the use of manures that India offers the greatest contrast to Japan. If the night-soil of Japan is worth Rs. 800 lakhs per annum, that of India must be worth six times as much. Yet only an infinitesimal fraction of it is allowed to have anything like its full effect on the soil. The question is bound up with the social habits and prejudices of the people, but fortunately there are signs that the prejudices on this subject are breaking down, and in the future we may look to a more extended use of this valuable manure. The cattle manure annually produced in India with its 80,000,000 cattle and buffaloes, may be worth anything from Rs. 150 crores to twice or three times that sum according to the methods of conservation employed. Only a small proportion of this ever reaches the soil, the great bulk of it being consumed as fuel. The waste, deplorable though it may be, is to a great extent inevitable under present conditions, and can only be obviated by the general

establishment of forest reserves, which, again, is a very large question.

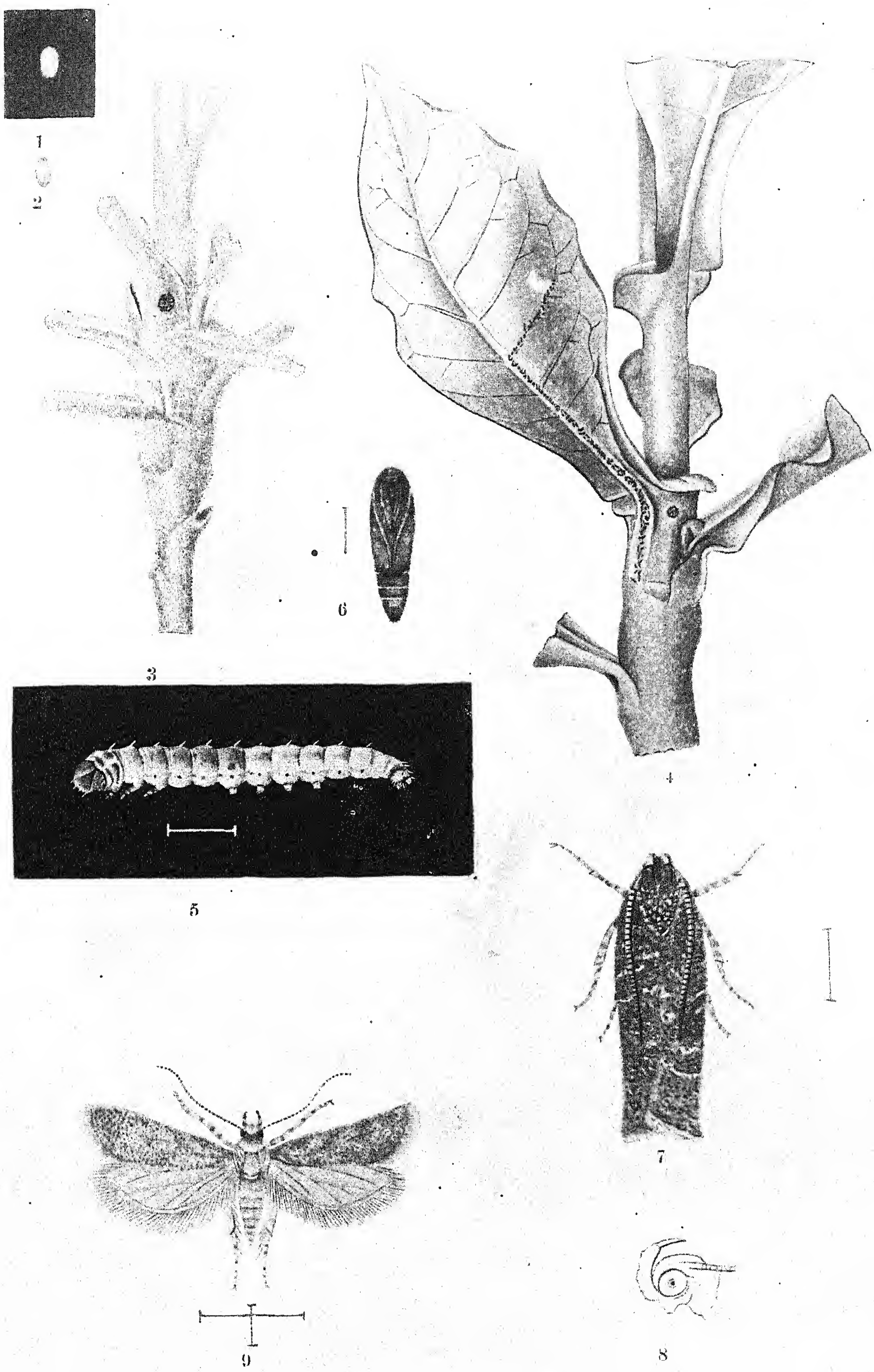
The present large export of oil-seeds and of bones constitutes a severe drain on the country. The use of oil-cakes for feeding and manure is, however, becoming more and more general ; and as the resources of the people improve, there will no doubt be not only a much diminished export of oil-seeds, but a much wider utilization of the seeds of forest trees, many of which, though at present of little commercial value, possess valuable manurial properties. Bones are most usefully employed as a manure in the form of superphosphate, but the present high price in India of the sulphuric acid used in the manufacture of superphosphate encourages their export. As regards compost, there is not the same mass of compost material available in India as in Japan, but comparatively little effort is made to utilise such material as there is. Green manuring is practised to a considerable extent, especially in "garden" cultivation, but might, with advantage, be more generally employed.

We would call special attention to one feature of Japanese agricultural policy, *viz.*, the encouragement of consolidation of holdings. This is a question which must sooner or later be taken up in India. The difficulties in carrying through the work would undoubtedly be enormous, but not greater than they have been in other countries. The advantages of consolidation are patent to all, the average cultivator included. Some of the more obvious are economy of labour and of space,—in Japan it has been found that there is sometimes a saving of as much as 5 per cent. of land through the breaking down of division boundaries—the better distribution of manure, the greater care of fields and crops, the fostering of individuality and the loosening of the bonds of village tradition and prejudice.

With regard to agricultural education and research and the organisation of agricultural associations, we are a long way behind Japan ; but with the Department of Agriculture now being organised, we may expect much more rapid progress in this direction in the future.

Sir Frederic Nicholson's Note has been written primarily for Madras, but his wide knowledge of Indian agricultural conditions and his admirable presentation of the salient features of Japanese agriculture makes it possess an interest for all students of Indian agriculture. We await with interest the second edition of the Note in which he has promised to give suggestions for Madras.

PLATE XIX.



TOBACCO STEM BORER.

THE TOBACCO STEM BORER.

(*Gnorimoschema heliopa*, Low).

By H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S.,

Imperial Entomologist, Pusa.

The cultivated tobacco plant in India is attacked by few pests, and these chiefly are insects which only attack this crop sporadically, and which have a large range of other food plants. There is, however, one insect which is a specific pest to this plant and to no other. This insect is figured in all stages in Plate XIX. The moth is shown with expanded wings as if flying in Figure 9 (the lines below indicating the real size), while in Figure 7 is shown the moth as it rests on a plant, the wings being wrapped round the upper part of the body. The moth is too small and too much like other small brown moths to be easily recognised, but the Figure 8, showing in outline the sickle-shaped palpi curving over the front of the head, will assist identification.

The moth flies about at dusk and after, and lays eggs on the young tobacco plants. An egg, eight times the real length, is shown in Figure 1; it is, when first laid, greenish yellow, but slowly darkens to the browner tint shown in Figure 2. A single moth was seen to lay 58 eggs, but normally each probably lays more. In the cold weather the egg hatches in a fortnight to three weeks, and in warm weather (March) in eleven days. These eggs cannot easily be found as they are laid singly on the leaves, stems or leaf stalks, usually on the lower side. From the egg there hatches a caterpillar, a tiny almost white insect of the form shown in Figure 5, but measuring only $\frac{1}{25}$th of an inch in length.

This caterpillar very soon after hatching, eats into the leaf or stem near where the egg was laid; it goes completely inside, not mining close to the surface; if it enters the leaf, it works down a vein to the midrib, along the midrib towards the stem, until usually it reaches the main stem of the shoot. Figure 4 illustrates this, the larva having gone in at the white spot on the left leaf, and tunnelled down to the stem, its track being just visible as a dotted line. It lives secure within the stem, gradually increasing in size until it measures nearly half an inch. Such a full-grown caterpillar is shown in Figure 5, magnified five times in length.

The caterpillar lives and feeds in the stem for a period varying from six to ten weeks in the cold weather; one was found to take eight days in actually reaching the stem through the midrib; when there, the caterpillar eats the tissue of the plant and, if such a plant is cut open, little tunnels are found in the tissues; as a result of this attack, the stem swells, and one sees the bulbous swelling on the growing plant, shown in Figure 3. This is the external sign of the insect's presence and it only forms when the caterpillar has been in the stem for at least three weeks, sometimes longer. When the caterpillar is fully fed up and full grown, it bites a hole through the epidermis of the plant, so as to allow of the exit of the moth and then, to prevent enemies getting in, it webs up the hole with silk and grass; these holes are shown in Figures 3 and 4 and, if closed, show that the insect is within; the caterpillar then lines its tunnel with silk and turns to the chrysalis, the resting stage shown in Figure 6. It is, of course, impossible to see what is going on inside the plant, but in four cases that were specially treated, the chrysalis period was found to be about four weeks in the cold weather, less than three weeks (18 days) in warmer weather.

At the end of this time the moth comes out of the chrysalis, bursts through the webbed-up hole and emerges to the open air to mate and lay eggs. Moths only come out at dusk and rest by day hidden. It is uncertain how long they live, but if they find mates and growing tobacco, they lay eggs in three or four days and a fresh brood starts.

In the cold weather, when the insect is breeding in tobacco, the whole life from egg to egg occupies from three to nearly four months and, so far as the tobacco crop is usually concerned, there is but one brood in it. The insect lives by choice in either young plants or in young shoots ; one finds it abundantly sometimes in the plants after transplantation, and later, in the shoots that spring up from the stumps after the tobacco is cut.

As a general rule, the presence of one caterpillar in a young plant does no more than make the plant weak, stunted and poor. The plant dies only when several caterpillars are in it at once, and this occurs but seldom where tobacco is grown as a crop. Loss of crop comes then not so much from the death of the plants as from the unthrifty weak plants which yield little, and where tobacco is an important crop and in the field successively more than once in the year, there is sometimes enough of this pest to considerably diminish the outturn. The insect has been found in all the important tobacco-growing districts in India and is known in Ceylon, Java and other places.

Like other insects, this one is prone to attack the most choice special varieties as readily and sometimes more readily than ordinary indigenous kinds, and it has possibly been a factor that determined the rejection of some varieties that would have done better had not their growth been checked. It is impossible to estimate the loss in the tobacco cultivation at present ; it is probably small but constant.

My object in this paper is to draw attention to this insect and to its life history, as it is the sole specific pest of tobacco. Little can be said about prevention because what can be done must be by common-sense methods based on a knowledge of the life history of the insect. From the practical point two measures are important : the first is to watch the young crop and pull out and burn all plants that show swellings ; that checks the pest's multiplication and it may be seen early enough to put in other plants in place of those taken. The second is to thoroughly eradicate the tobacco stumps after the tobacco is cut, so that they cannot send up shoots in which the insect can breed and so

multiply. In Behar the brood in the shoots from the cut stumps in April and May is sometimes a large one, tiding the insect over until the rains and probably materially adding to its number for the next crop.

When tobacco grows wild, the plant should be eradicated as this is the original source of the mischief. This precaution is, however, not one that is of much real importance. What other food plants this insect has is uncertain; very possibly it breeds also in other solanaceous plants, but it has not been observed on any other cultivated plant. It would certainly have been found, did it breed in any.

In tobacco-growing districts in India where this borer is well known, as in Gujarat, the cultivator has a remedy; it consists in making a vertical cut in the swollen part of the stem with a sharp knife; the explanation given is that this lets in air which is good for the diseased plant and the cultivator regards the swelling in the stem in much the same way as he would a tumour on his own person, *not connecting it with the presence of an insect at all.* Experiments made with this treatment show that unless the knife actually reaches the caterpillar inside the stem, the treatment produces no result; if the caterpillar is killed, which happens very seldom, the plant does thrive better than if the caterpillar had not been destroyed, but a strong plant is not produced; practically speaking, the mischief is done by the time the swelling can be seen and no cutting will produce a good plant. Where there are several caterpillars in one stem, as often happens, cutting has no effect whatever unless so vigorously done as to kill the plant.

NOTES.

Flax Cultivation in Bengal.—The Director of Agriculture, Bengal, has issued a note describing the results of the preliminary experiments in Bengal with Russian (Riga) flax seed distributed in 1906. The most promising results appear to have been obtained at Bankipore, where the outturn of green plant was $2\frac{1}{2}$ tons per acre. Elsewhere owing to late sowing and an unfavourable season the crops were less promising. A sample of flax grown at Bankipore was sent for examination to the Imperial Institute, London ; the Director reported that the fibre was longer and coarser than the standard samples from Belgium. The clean fibre obtained from the Indian straw had an average diameter of 0·00094 inch, the diameter of a standard sample of Belgian flax being 0·00086 inch. The fibre was found to contain in parts a considerable amount of woody tissue. The Director of the Imperial Institute suggests that in order to ensure the best quality of fibre, the crop should be harvested when the lower half of the straw has turned brownish yellow, and not when ripe. We have now full and practical advice from the Flax Expert on this and many other plants which are essential to the successful cultivation of flax in Bengal, and we attach much greater value to the results of the local experience gained by this officer than to advice given from the Imperial Institute.

In a preliminary note on flax cultivation in Behar, the Flax Expert to the Behar Indigo Planters' Association suggests that the most desirable length of flax is from 28 to 35 inches. Longer fibre is less valuable. He states that in Belgium 300 to 370 lbs. of seed is sown per hectare (hectare = 2·4711 acres), adding 50 lbs. of seed where the soil is poor. The crop should not be forced by

heavy manures but should be grown, however, on land in good condition. He suggests that seed should be sown by drill in Bengal. He further gives his opinion about retting, necessary machinery, the quality and class of fibre as compared with Belgium and the approximate value per ton of fibre and output per acre.

This note will be largely amplified by the results of work in 1907-1908, when published. These will tend to show that a profitable new industry is possibly being established in Bengal. All initial trials will necessarily be conducted with imported expensive seed, as the indigenous varieties are believed to be quite unsuitable for flax. The value of acclimatization and of plant to plant selection will be studied. We already know a good deal about how this crop can be most economically grown and otherwise dealt with. We, however, need in particular better knowledge regarding the most suitable water and temperature for the retting process in India.—(EDITOR).

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MILKING MACHINES.—One maker claims to have sold 1,500 machines of one pattern in Australia, capable of milking 3,500 cows. In the *Agricultural News* for 19th October 1907 appears an account of a new type of machine recently put on the market in the United States of America. It is said to consist, in the first place, of a large pail with a tightly fitting lid. From nozzles on the lid are given off two India-rubber tubes, about 3 ft. long, each of which terminates in four funnel-like India-rubber cups, which fit tightly on the teats of a cow, two animals being milked at once. Two pipes pass round the cow stalls, one being a vacuum, and the other full of air at high pressure. An essential feature of this milker is the pumping apparatus, mounted on the lid, which in alternate pulsations connects the pail, and consequently the India-rubber tubing, first with the vacuum (the result of which is to create a suction, and so to extract the milk), and secondly, with the air pressure pipe, which releases the teat preparatory to again applying the suction, the extracted milk meanwhile passing from the cups, through the tubing and into the pail.

This type of machine corresponds in action to a machine introduced within recent years in England. The writer saw one at work in a large dairy in Scotland. It replaced with excellent results 15 hand milkers who dealt with 150 cows, and who had to work seven days per week and were consequently paid very high wages.—(Editor).

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Cassava.—The Cassava plant serves two useful purposes. Its roots which swell into large tubers of a yellowish colour yield Cassava meal, Cassava starch and tapioca. The many branches into which the plant expands afford good food for cattle. Another characteristic of this plant is that its roots need not be lifted from the ground at the same season, but may be allowed to remain as a reserve stock of food with slight fear of being spoiled. It is a very productive plant, one acre of Cassava, under certain favourable conditions, yielding more nutritive matter than six times the same area under wheat. The plant grows to a height of from 4 to 8 feet and has noded stems. Its tubers are from 1 to 3 inches in diameter and usually over one foot long. It flourishes most in a well-drained sandy loam. The tubers decay if the ground is water-logged. The soil should be well ploughed to a depth of 6 to 12 inches. Full-grown stems of the plant should be cut up into small pieces from 4 to 6 inches in length. These cuttings may be planted in the furrows and covered over like sugarcane cuttings, or may be set in the ground in a slanting position with about an inch above ground. The cuttings should be planted four feet apart in rows which must be also 4 feet distant from each other.

Hoeing and weeding are necessary only till the plants grow up, as its many branches afterwards hinder the growth of weeds. Generally from 8 to 12 months must elapse before the roots will be ready for lifting. The tubers when lifted should first be well washed and then immersed in cold water for a night. The dark coloured rind should then be peeled off with a sharp knife. The peeled tubers should be cut into small pieces, washed and crushed into a pulp which should then be put in a cloth bag

and, after subjection to heavy pressure to force out any poisonous juice, be washed, sifted and dried.—(EDITOR).

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THE BEHAR PLANTERS' ASSOCIATION WORK IN 1906-7.—The report of the Association covering the season 1906-7 is distinctly encouraging. The Association has been strengthened by the addition of some 14 concerns. The report mentions the grant of Rs. 50,000 made by the Bengal Government for the Sirsiah Research Station. During the period under review Mr. Bergtheil brought out two interesting publications—(1) Method of Estimation of Indigotin in Commercial Indigo, (2) Report on the Results of a Practical Dye-test of Natural against Synthetic Indigo. Another interesting publication "Treatment of Java-Natal seed with concentrated sulphuric acid" has been published by Mr. Briggs. The Association received a grant of Rs. 6,000 from the Bengal Government to meet the expenditure for the employment of a flax expert, and it is stated that Mr. Emil Van der Kerkover has been engaged on agreement for one year. He will report fully on the possibilities of growing flax in Behar before the expiration of his agreement. A further grant of Rs. 1,500 was made by the Bengal Government to assist purchasers of flax seed through the Dundee Chamber of Commerce. A passing reference is made to Dr. Leather's field experiments with phosphates, Dr. Butler's report on plants suffering from "Okta" and Mr. Lefroy's report on the "Psylla" disease.—(EDITOR).

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REMARKS ON THE SUGGESTION BY MR. PUNNET REGARDING THE APPLICATION OF THE PRINCIPLES OF MENDELISM TO THE IMPROVEMENT OF JUTE.—For two years, work has been proceeding in jute improvement, as yet only by simple selection; but it is hoped to commence cross-breeding experiments very soon. We are endeavouring to extend the cultivation outside of Bengal, because Bengal is approaching its limits of production and the method of simple selection has proved extremely useful in connection with

acclimatization. In one case it has been possible in a single year to produce greatly improved results, in a new tract, by sowing seed selected from only the tallest and straightest plants of the previous year's crop. Simple selection is, therefore, undoubtedly of value under such circumstances.

When we come to the question of cross-breeding, we find we are on much more difficult ground. There are probably nearly a hundred so-called races of jute (*C. Capsularis* and *C. Olitorius*) in Bengal. It is possible to distinguish at once, of course, between red races and green races, early races and late races; but it is practically certain, for instance, that at least some early green races with different vernacular names are identical in every respect botanically and agriculturally. It is obviously necessary, therefore, before commencing any cross-breeding work to decide which of the so-called races are identical and which are not. Mr. Burkill, the Reporter on Economic Products, and the author have given a good deal of attention to this point during the last two seasons, and Mr. Burkill has visited practically the whole of the jute-growing districts during 1904, 1906 and 1907 for the purpose of making observations. The plots at Pusa and those at Burdwan have also been under strict observation, the latter since 1902. The results are encouraging; and it is hoped that, when taken in conjunction with chemical and microscopic examination of the respective fibres, a sound basis for further work will soon be arrived at. We hope as a result of this year's work to be able to start with a definite programme for raising new races next season. While this work promises to be of very great scientific as well as practical interest, the intrinsically inferior nature of jute fibre, when compared with other fibres in India, renders it doubtful whether it is wise to attempt to improve the quality of jute beyond a certain point, if the outturn of fibre per acre cannot also be increased by the methods of improvement adopted. Other plants are already under examination whose fibre is certainly much finer in quality than jute and which give promise of yielding such a return per acre as will enable them to compete with the higher priced samples of jute. Inherent in

these fibres are some of the qualities which we are seeking to develop in jute.—(Robert S. Finlow).

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Aman Paddy.—The manurial experiments at the Burdwan Farm from 1891 to 1906 have proved that for Aman Paddy 3 maunds of bone-meal and 30 seers of saltpetre per acre have given the largest yield. This manure yielded an average outturn per acre of $50\frac{3}{4}$ maunds of grain and $73\frac{5}{8}$ maunds of straw, as compared with an average of $19\frac{1}{5}$ maunds of grain and 32 maunds of straw from comparative unmanured plots. Six maunds of bone-meal alone per acre gave on the average $45\frac{1}{2}$ maunds of grain and $71\frac{1}{8}$ maunds of straw; whilst an application of 3 maunds of bone-meal gave on an average 42 maunds of grain and $60\frac{1}{5}$ maunds of straw. The outturn yielded by 3 maunds of bone-meal alone compared with 3 maunds of bone-meal plus 30 seers of saltpetre shows that the addition of 30 seers of saltpetre repays its cost many times over. It has been proved that it is not economical to apply more than 3 maunds of bone-meal.

In the same period 50 maunds of cowdung per acre gave an average outturn of $40\frac{1}{8}$ maunds of grain and $55\frac{3}{4}$ maunds of straw. But 100 maunds of cowdung produced on an average only $41\frac{1}{2}$ maunds of grain and $55\frac{1}{8}$ maunds of straw. It is believed, therefore, that a heavy dressing of cowdung is wasted. An economical dressing appears to be 50 maunds of cowdung or 3 maunds of bone-meal plus 30 seers of saltpetre. It is further suggested that if artificial manures are not available, green manuring should be practised.

Experiments during the last three years in planting paddy seedlings at different distances, showed that a distance of from 9 to 15 inches apart, gives the best outturn. This experience does not apply to those parts of India where seedlings are usually planted in clumps some four or six inches apart.—(Editor).

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Indigo Research.—Mr. Eugene C. Schrottky, who has recently been employed by the U. P. Government to demonstrate

at Gazia the merits of up-to-date methods of indigo manufacture to the planters of the United Provinces, has published in the form of a leaflet, the results of his indigo research work in the season 1907, carried on in private factories at Buthnaha, Turcouliah and Sathi. Aiming at a better fermentation of the plant, a more perfect separation and a larger gain of the dye, he tried the glucosōde and the alkali and acid processes and also the establishment of a second steeping of the indigo plant. He asserts that the glucosōde process not only yields for 100 maunds of green plant, 4 to 5 seers of 65 per cent. indigo more than the average yield by the ordinary process, but it has another advantage in respect of giving good returns, even when the plant is not ripe for manufacture or when the moisture in the plant is so diluted by rain-water as to retard the progress of fermentation. Manufacture of indigo by this process can, he says, be carried on at any time between March and November. The most suitable temperature of the steeping water for glucosōde vats is 95° to 86° F. The best separation of the dye can, it is said, be effected by the alkali and acid process. In this process the quality of indigo can be kept entirely under command by the proper use of acid in sufficient quantities to redissolve the organic and mineral matter precipitated with the dye and by regulating the quantity of water used to remove again the soluble impurities from the fecula. The fermented liquor worked upon with the glucosōde process resists decomposition, and a second steeping of the plant can be easily effected. Mr. Schrottky says that the second steeping process yields 40 per cent. more dye and the three processes together, though expensive (owing to use of chemicals, etc.), "leaves the planter a most handsome margin of profit." My department does not, necessarily, endorse Mr. Schrottky's views, but I am very glad to give them publicity in this Journal.—(EDITOR).

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IMPROVED SEED MAIZE.—By G. L. Sutton.—*Agricultural Gazette of New South Wales*, Vol. XVIII, Part 10.

In this article Mr. Sutton deals with the methods of improving seed maize according to the latest scientific knowledge

on the subject. In most countries where maize is grown selection of some sort takes place. Thus, in Australia the seed from the largest cobs only is used; in South Africa, the seed from the middle portion of the best cobs is considered best. These methods especially the latter, are no doubt very good, but, as Mr. Sutton points out, they take no account of the influence of the male flowers on the seed. Every seed derives its origin from two units—the male "pollen" and the female "ovule or egg," each of which contributes equally in the formation of the character of the seed.

In the case of maize the male flower is generally called the "Tassel" and the female flower the "Silk." Each of the hairs in a "silk" flower is attached to an ovary containing an ovule. The seed is formed only when pollen from the male flower is carried by the wind on to the silk, each pollen grain fertilizing one egg. Now, it is apparent, since the laws of reproduction are the same in plants and animals, that if pollen from a weakly or sterile plant falls on the silk of another, the resulting seed is bound to be poor though the female flower may have been a very good one. Hence fine ears or cobs do not always produce fine seed, as an experiment at the Ohio Experiment Station shows. In this station 24 different ears were selected of the same size and germinating capacity. The grain from each ear was planted in a separate row, so that each had the same chance. The yields from the three best rows were at the rate of 114, 112 and 104 bushels per acre respectively. The row which yielded least produced 55 bushels per acre. There were 58 barren stalks in this row.

The improvement of seed by intelligent breeding is carried on by farmers themselves in the United States and the yield thereby largely increased. The method is roughly as follows:—A number of fine cobs are selected and seed from each planted in separate rows. The area of experiment should be half a mile away from any other maize as pollen is carried a long distance by the wind. When the flowers appear, the "tassel" is removed from alternate rows leaving only mother plants. This ensures that all seed in a "detasselled" row will be the result of cross-fertilization. All sterile plants (*i.e.*, those without female flowers) should

be removed from all the rows as they are undesirable males to breed from. For the following year the best cob from each "mother" or "detasselled" row should be selected and sowing proceeded with on the same lines as above. It was found at Cowra, the New South Wales Experiment Station, that after the first year no sterile plants appeared. The article is well illustrated by plates and should prove interesting to maize growers, especially in Behar.—(W. Roberts).

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A Premium for Pure Cotton Fields.—In the year 1906 an experiment was instituted in the districts of Kurnool and Cuddappah (Madras) of giving a premium of annas 2 per acre on all practically pure cotton fields. The object in view was to induce the ryots to cultivate a pure crop of any of the four varieties, Yerrapatti, Tellapatti, Gadag and Cocanadas, generally grown in the districts. The rewards were given after the crops had been declared to be pure by inspecting officers with special knowledge of particular varieties. In some cases inspecting officers had received special instructions from the officers of the Agricultural Department. The rewards have had some effect in inducing the cultivators to pay some attention to seed selection. The acting Government Botanist recommended that the reward to be effectual must be 8 annas per acre for the growers of Gadag cotton on black soil and Yerrapatti on red soil, but it has not been thought advisable to follow the recommendation. The experiments will be continued. It is, however, doubtful if there will be much practical outcome.—(Editor).

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Egyptian Cotton in the North-West Frontier Province.—With a view to test the suitability of the North-West Frontier Province for growing Egyptian Cotton, the Revenue Commissioner arranged in 1906 for preliminary trials with the seed supplied by the office of the Inspector-General of Agriculture in India. The trials were made at eight places in the Province on land which was carefully cultivated, manured and irrigated. The plants in all cases grew to a height of about 7 to 8 feet and flowered, but

dried away in the month of October without yielding any cotton.—(EDITOR).

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THE SEED OF NYMPHÆA LOTUS.—The seed of *Nymphæa Lotus*, which is very plentiful in the Koller Lake, is known in the Kistna District, Madras, as *Allyalu*, the whole plant being called *Alli*. The plant occurring in the Koller Lake bears white flowers. It is met with, though not abundantly, in other parts of the Presidency. While the seed and the fleshy root of the plant are used as articles of diet by the lower classes of people inhabiting the villages bordering on the Koller Lake, their dietetic value is quite unknown elsewhere. A Christian gentleman who had recently returned to India from Japan referred, in a lecture delivered on the manners and customs of the Japanese, to the fact of lotus roots being used as food by the Japanese. Whether these people use lotus seed as food is not known.

The *Wuddis*, *Malas* and other low classes of people go out on rafts or in hollowed trunks of the palmyra, in the Koller Lake in November and December, to gather various products, of which the fruit of *Nymphæa Lotus* is the chief. The fruit is roundish and brownish red. It is kept soaked in cowdung in a basket for three days, when it is pounded and the seed separated. The seed somewhat resembles *ragi* when thoroughly husked, and is of dirty white colour. It is boiled like rice and thus eaten or ground to flour and made into cakes. It is considered specially good for people suffering from beri-beri. It is very palatable, but is not so nutritious as rice, cholam or other grain. It is extensively consumed, specially in times of scarcity, by the classes of people above referred to. Last year, the price of the seed in the villages bordering on the Koller Lake, was so high as Rs. 40 per candy of 500 lbs., that is, half the price of paddy.

The root of the plant is cooked and eaten as curry.—(C. K. SUBBA RAO).

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COTTON WILT IN THE CENTRAL PROVINCES.—This disease was noted on the Experimental Farm, Nagpur, this season, and this

is apparently the first authentic instance of its appearance in these Provinces.

A field of Bani cotton, a local variety of rather fine staple, was first attacked. This crop was growing on a piece of land in rather high condition which had been cropped with Juar the year before. The cotton plants were very vigorous and healthy-looking, and gave promise of an excellent crop. The first signs of disease were noted at the end of August, when scattered plants were noticed to turn yellow, the leaves to wilt and the whole plant to die and dry up. An attacked plant was often noticed to have completely died within twenty-four hours. On pulling up diseased plants a ring of the bark at the point of junction of the stem and root was found to have turned brown and to be in a decomposed state, while immediately above this ring the base of the stem was covered with large unhealthy-looking swellings which in a later stage are frequently attacked by white ants; these insects being at first suspected of having caused the injury to the plant. Specimens of the diseased plants were forwarded to Dr. Butler for examination and have been identified as suffering from the cotton wilt disease (*Neocosmospora vasinfecta* Smith). Meanwhile, on the other parts of the Farm, Jari and other Indian varieties had been attacked to a less extent, but it was curious to note that American Upland varieties, which were growing round the edges of the first attacked plot, were not attacked, nor could a single instance of an American cotton plant suffering from this disease be found. In less than three weeks, this disease was entirely stamped out by cutting and burning the diseased plants, and this result was helped, no doubt, by the early cessation of the rains.

On wider enquiries being made, cotton was reported to be diseased in several places in the Nagpur District, and in the Saoner tract where, owing to the recent cotton boom, this crop is grown without proper regard to rotation, it was estimated that nearly 5 per cent. of the crop had been killed in places by this disease. Cultivators state that this disease has been occasionally seen for the last three or four years, but has only been common

this season. The curious part is that in this District also it is not found on the American cottons. Heavily manured crops are most frequently attacked, and possibly the disease has lately become severe owing to the abandonment of a proper rotation for cotton in certain of the more favoured cotton tracts of this Province.—(G. EVANS).

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DESTRUCTION OF RATS BY RATIN.—A special preparation called 'Ratin' for the destruction of rats and mice was tried in Germany with successful results. To test whether it would be of use in India, experiments were made by the Civil Veterinary Department both in the field and in the Laboratory. The results have been disappointing, the preparation having been found to be ineffective. This experience is corroborated by the results of the experiments conducted on an extensive scale by the Plague Department and in the Mysore State. The ineffectiveness may be due to the ratin having lost potency as it only keeps good for about two months after manufacture.—(EDITOR).

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EXPERIMENTS ON WELL-SINKING IN THE AHMEDNAGAR DISTRICT.—A simple system of well-boring has been tested by the Collector of Ahmednagar (Bombay Presidency). A cast-iron or mild steel Jumper bar is used. This tool is not expensive. It should be 13 to 17 inches long and $1\frac{1}{4}$ inches in diameter. The top has a hook whereby the implement is raised from the bored hole. At its lower end is a steeled chisel. The chisel should be twisted slightly by a cooly each time it descends. Thus the sub-strata are broken up and excavated and removed in water. Five men are required for this system of boring.

For deep boring a rope passed over a pulley should be attached to the hook of the bar. The depth, thus reached, is usually below the depth of existing wells. This work in two days costs about Rs. 5. The results and personal experience indicate that additional supplies of water can, in many parts of India, be easily and cheaply obtained by boring 20 or more feet

below the floor of existing wells. This does not of course hold good in all districts.—(EDITOR).

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JUTE EXPERIMENTS IN SOUTH BEHAR.—At the instance of the Director of Agriculture, Bengal, an interesting trial was made with jute in 1906, by a member of the Patna Divisional Agricultural Association near Itarhi in the Buxar Sub-division of Shahabad. The land selected only measured about three-eighths of an acre. The soil was a low-lying soft loam adjoining a big pool of water. The seed was sown in April in beds laid out for irrigation. Five or six waterings were given till the commencement of rain. No manure was applied. The land was, however, naturally fertile. The rains were favourable. The plants grew to a height of 10 feet and more. The plants were retted in September and the fibre extracted by hand in the ordinary way. The total yield per acre was 21 maunds of fibre valued at Rs. 168. The cost of all the operations amounted to Rs. 25 only, so that the net profit per acre was Rs. 143. Paddy was grown on the same field after the removal of jute, the outturn of which was found to be 16 maunds per acre valued at Rs. 40. These promising results have encouraged the member to continue the experiments on an extended scale this year, and he hopes to be soon in a position to say what the general prospects of jute are in the Shahabad District.—(EDITOR).

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METHOD OF BREEDING PLANTS FOR FIXING THE CHARACTER IN A SINGLE GENERATION SAID TO HAVE BEEN INVENTED BY DR. NELSON OF SWEDEN.—The Svalof Experimenters have found that the fluctuating variability is of little use in the production of new varieties of cereals, but all the varieties at present cultivated are made up of large numbers of unit species differing widely among themselves in Botanical and Economical properties. Once isolated, these unit species merely require to be propagated before being placed on the market.

There was also found to be an association of characters between the small morphological characters on the exterior of

these unit species and important economic properties. Thus, observation showed that in Barley stiff spreading hairs on the scales, are correlated with good malting qualities ; a fact of the utmost importance in the initial selection of a new race. Of course, there is a vast amount of book-keeping and laboratory work entailed in the discovery and recording of these associated characters, and a large staff of experts is kept for the purpose at Svalof ; but, once these correlated characters are known, it is only necessary to search for the correlated botanical marks in order to improve any given local variety in any character in which it may be deficient.

The results obtained at Svalof are published at intervals in Swedish. The Agricultural Station there is not supported by Government, but is a commercial undertaking for the improvement and distribution of seed grain. There is an account of the work of the Svalof station in *De Vries' Plant Breeding (London : Kegan Paul, Trench, Trübner & Co., Ld.).* De Vries also gives a chapter on Corn breeding, and devotes a long article to Burbank's Horticultural Novelties, in which article he shows what use Burbank has made of hybridization on scientific lines and of associated characters. At the end of the book he has some very interesting remarks on correlation and the geographical distribution of plants. In fact, this is quite the most useful book that has recently appeared on plant breeding.

The following is a list of the recent works on the subject published in English :—

Royal Horticultural Society—

Report of Third International Conference on Genetics. Spottiswood & Co.

Royal Society—

Three reports of the Evolution Committee. Harrison & Sons, St. Martin's Lane.

Mendelism. By R. C. Punnett. (2nd Edition.) Macmillan & Boures, Cambridge.

Plant Breeding. By Bailey, Macmillan.

Recent advances in the Study of Evolution and Heredity. By Locke.

Journal of Agricultural Science for R. H. Biffin's work.

Of these the reports of the Evolution Committee of the Royal Society are of purely scientific interest, as they contain an account of the original work done by Bateson and Punnett (Saunders & Co.) on the subject. The Royal Horticultural Society's report is of distinctly practical interest, as is Mr. Biffin's work in the Journal of Agricultural Science.

Of the books, Bailey's Plant Breeding is somewhat out of date, as most of it has not been re-written for some ten years, and in its earlier pages merely gives an account of the old empirical formulæ adopted by breeders, before the present scientific methods had been introduced.—(WOODHOUSE).

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WELL-BORING IN CHINGLEPUT DISTRICT.—During three months, ending 30th June, 1907, very useful results were obtained in well-boring in the Chingleput District, Madras. Fourteen second borings were made in existing wells. In these borings pipes were placed which reached to artesian water. Forty-one borings were made in existing wells and seventeen in new wells. In almost all cases the borings resulted in increased water. The existence of artesian water was more easily ascertained by boring in old wells than in new wells. The extent of artesian water has not yet been definitely determined in any district of the Punjab. Therefore cultivators cannot yet be advised where to dig in order to tap this extra water-supply. An iron pipe of 4 inches diameter, which may be required for successful artesian boring, costs about a rupee a foot. The expenditure in boring to artesian water may amount to Rs. 20 or Rs. 30 for each well.

Well-boring has become popular in the Chingleput District. Private enterprise has then been stimulated and valuable practical results are likely to follow.—(EDITOR).

LITERATURE.

United States Department of Agriculture, Farmers' Bulletin No. 257. Soil Fertility. By Milton Whitney.—In this Bulletin, which is an address to a farmers' club, we have stated in popular form the conclusions at which, after several years' investigation, the Bureau of Soils in the U. S. Department of Agriculture have arrived regarding the question of soil fertility. These are absolutely revolutionary in character. In the first place, they hold that the examination by them of hundreds of soils of all sorts in the United States has established that the composition and concentration of the soil moisture with respect to the common plant foods—nitrates, potash, phosphates, lime—is practically the same in all soils, and that this composition is constantly maintained. If, then, there is in general a sufficiency of plant food immediately available to crops, to what can ordinary infertility in soils be ascribed? This question is answered by restating and greatly extending the old excretory theory first propounded by De Candolle and for a time supported by Liebig. We cannot here examine the experiments on which this theory is based, but we may admit that as far as laboratory experiments go, the Bureau of Soils have brought forward sufficient evidence to establish the fact that toxic substances are excreted by the roots of growing plants, that these substances are deleterious to plants of the species by which they were produced and often to a considerable extent to closely related species, but are frequently innocuous to other families or orders of plants, and that they are destroyed or neutralised by the application of such fertilisers as farm yard manure and green manure and of such non-fertilisers as carbon black, ferric hydrate and pyrogallol. But when from

the results of these experiments and their conclusions regarding the constancy of the composition of soil moisture, they argue that the chief function of cultivation and of fertilisers is not to make available or supply plant food but to break up toxins, we confess that we shall require much stronger evidence before we can agree with them. When they have demonstrated in the field over a series of years that by the application of carbon black or ferric hydrate alone they can produce crops equal to those grown after a full dose of fertiliser, we shall be convinced.—(E. SHEARER).

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ANNUAL REPORT OF THE BOARD OF SCIENTIFIC ADVICE FOR 1905-1906.—The Board of Scientific Advice was constituted in 1902 to co-ordinate official scientific inquiry and to ensure the proper distribution of the work of research among different departments of science. The Board advises the Government of India on questions of economic and applied science, especially on the questions of industrial development. The present report, covering the period from April 1st, 1905, to March 31st, 1906, summarises the work of the several departments which deal with scientific investigation.

"Economic and Industrial Chemistry" records the examination of several wild and cultivated Indian varieties of Ficus. The result of the examination has proved that only "Ficus Elastica" yields satisfactory India-rubber. The most interesting part of the report is that which records the results of analysis to ascertain the value of particular stuffs as famine foods. Among the articles submitted to this chemical analysis were the following:—roots of *Costus Speciosus*, the seeds of *Ormosia Tavoyana*, roots of *Sterculia Villosa*, and some edible earths. The first two were found to be fairly nutritious, while the rest were found to have no food value in them. The report notices the experiments made to ascertain the conditions under which cyanogenetic glucosides are found in excessive quantity in Sorghum and other cultivated plants. The general idea that the presence of these glucosides is associated with certain varieties of these crops is not supported, since the same variety may contain at

different stages of growth very different quantities of its characteristic glucosides. The immature plant of *Andropogon Sorghum*, generally held to be poisonous, was found to be entirely free from any poisonous element when cultivated at Pusa. The report takes note of the construction at Pusa of four gauges designed to measure the amount and quality of the water which drains into the subsoil.

In the section devoted to Botanical Survey mention is made of an interesting book by Professor J. C. Bose, on "Plant Response as a means of Physiological Investigation" and of an important Memoir on "Root Parasitism" by Mr. Barber.

In the domain of Agricultural Botany Mr. Gammie has contributed an important paper on "Indian Cottons." Further enquiry carried on to ascertain the cause of the deterioration of the jute fibre has brought to light the fact that the deterioration of the fibre is due in large extent to fraudulent watering and that the shortage of supply induces buyers to purchase even the most inferior qualities. The report briefly notices the attempts made to ascertain how far outbreaks of insect-pests can be checked by the dissemination of disease amongst them. Of the fungus parasites occurring in harmful insects, the locust fungus has been credited with the power of destroying locusts in South Africa. A series of tests with this locust fungus was carried out on the Bombay and North-Western locusts and some species of grass-hoppers destructive to crops. The results were unsuccessful, but now it is understood that the true locust fungus was not that which was introduced for the purpose of these experiments, and therefore there is a very good reason for failure. Note is also taken of the failure of experiments to check the green bug of Coffee by means of a fungus parasite imported from the United States of America which attacks various scale insects.

The whole of the section on "Forest Products" affords instructive reading to those who have both sufficient means and enterprise to develop new industries. In this section are mentioned the important investigations made at Rangoon for utilizing in the form of pulp, inferior kinds of timber and bamboos

for the manufacture of cheap paper. The paper produced is poor in quality. It may only therefore pay to manufacture pulp on a large scale from bamboos and export it to Europe.

The bamboo pulp is decidedly of high quality and leaves a margin of profit even after the payment of freight and other charges incidental to its export. We are further told that investigations are in progress to ascertain how the cultivation of the lac insect can be improved and extended, and what is the best season for gathering lac.—(EDITOR).

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REPORT ON THE WORKING OF CO-OPERATIVE CREDIT SOCIETIES IN THE MADRAS PRESIDENCY IN THE 15TH MONTH ENDING 30TH JUNE 1907.—During the period under report, 36 new societies were registered. Of these 24 were rural and 12 were urban. All the rural societies were based on the principle of unlimited liability. Most of the new societies were started in districts in which similar institutions were already in existence. The aggregate number of members rose from 2,733 to 6,439. Of this number 31 per cent. were agriculturists, and 37 per cent. were those who partly followed agriculture and partly other occupations. Besides the paid-up share capital of these societies, fixed deposits were borrowed on interest from 5 to 9 per cent. More than two-thirds of these deposits were contributed by the members themselves. The amount lent by Government was nearly as much as the share-capital and fixed deposits of these societies.

Certain concessions granted by the Madras Government have raised the prestige of these societies in the eyes of the public and have created a feeling of confidence and security. The annual reports of the societies with the registrar's audit reviews thereon are published in the District Gazettes, and are supplied free of charge to all rural societies. Remittance transfer receipts are issued at par so that remittances can be sent without extra charge. The societies' strong boxes can be kept in Government treasuries for security.—(EDITOR).

THE INTRODUCTION OF IMPROVEMENTS INTO INDIAN AGRICULTURE.

By D. CLOUSTON, B.SC.,

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GOVERNMENT has organized during the past few years a strong department for the scientific investigation of Indian agriculture, with the object of ascertaining the lines upon which improvement is practicable. A staff of specialists, highly trained in the agricultural sciences, is employed both in the Imperial and Provincial departments, whose research and experimental work have already shown that many important improvements can be effected. These results are placed before the public in the reports and other publications issued from time to time, but such literature fails to reach the mass of Indian cultivators. It is, therefore, an essential function of the department, no less important than scientific investigation, to devise methods whereby experimental results of proved value can be introduced into ordinary farming practice by the Indian cultivator. The methods to be employed in bringing experimental work of proved value to the notice of the cultivator, so as to secure its adoption in ordinary farming practice, will necessarily vary in different parts of India in accordance with the varying local conditions, such as the system of land tenure, the standard of farming attained by the cultivators, the social condition of the rural community and the like. It may be of interest to give an account of the methods that have been tried in the Central Provinces, and of the lessons learnt from the successes and failures that have resulted.

In the Central Provinces the villages are held by landowners, whose proprietorship is clearly recognized, though their rights of ownership are subject to the rights of occupancy of their tenants. Both proprietor and tenant are given security of tenure in the land, with the object of encouraging each to make the best possible use of it. This system has given a number of village proprietors who often cultivate large home-farms—intelligent farmers, who are willing to test improved methods and to lay out substantial capital sums, if they are convinced that an adequate return is likely to be secured. Amongst the tenantry there is also a sprinkling of men who cultivate large holdings and employ large capital; and such men are even more numerous in the rich province of Berar, where the *ryotwari* system of tenure prevails. The difficulties in introducing improvements are, therefore, not so great as in a tract where the land is parcelled out into minute holdings, and where the capital at the disposal of each holder is extremely limited, for there are numbers of cultivators ready to expend some hundreds of rupees upon a new implement, an improved method of cultivation or the like, provided they are convinced that the outlay will give a substantial return. The standard of farming attained in different parts of these Provinces varies considerably, but it is on the whole inferior to that of most other parts of India, so that there is much more scope for improvement than in provinces where cultivation has already reached a high level. In the Central Provinces, as a rule, land is plentiful and intensive cultivation is but little practised; in Berar, on the other hand, the great boom in the cotton trade has enormously increased the demand for land, with the result that grazing areas have been curtailed and the standard of cultivation has reached a much higher level. Good cultivators are found, as exceptions, among all the different castes. The best cultivators are the hereditary cultivating castes such as *Kunbis*, *Powars* and *Lodhis*. Contrasted with these may be mentioned such castes as *Gonds* and *Chamars*. The former live a contented but unenterprising life in the hilly jungle tracts of poor soil. Satisfied with a low standard of comfort, they are for the present so

inaccessible and primitive, as to be altogether outside the sphere of the department's influence. The *Chamars*, who form the bulk of the cultivators in the Chhattisgarh rice country, though inferior cultivators, enjoy a lazy and stoical content which is opposed to everything an agricultural department can teach in the way of progress. Contrasted with these again may be mentioned the educated Brahman cultivator of Berar who, after having made his fortune at a profession or trade, has purchased land on which he is anxious to experiment with anything from tree cottons to steam ploughs. The kind of improvements necessary, and the lines to be followed in introducing them among cultivators, can only be satisfactorily determined after studying all these conditions as they obtain in the different tracts. In the more backward parts, it is often some means of demonstrating better tillage methods that has to be considered ; the Chhattisgarhi, for instance, has yet to learn the very elements of his art, *i.e.*, to cultivate his land properly, to conserve the manure already at his disposal, and to sow his crops efficiently. In more advanced tracts, on the other hand, what is necessary is to organize a system of seed farms from which supplies of pure and improved seed can be obtained, to introduce new and improved varieties of seeds, to teach definite but simple methods of preventing and remedying insect pests and of supplementing the present supply of manure. Every scheme for demonstrating the results of experimental work to the ordinary cultivator must, then, be based on a knowledge of the different tracts and of the people and their needs.

Wherever possible, our teaching should be in the concrete. This can best be done by means of demonstration farms. On these farms many experimental results of proved value can be demonstrated on a practical scale, so as to secure their application to the general practice of farmers. Experimental work should never be attempted on these farms ; first experiment, and then demonstrate the results if they are of any practical value, should be the rule. To do this effectively, an experiment station has been located in each well-defined agricultural tract, and the

experimental programme is based on a knowledge of the agricultural requirements of the tract which it represents. The demonstration farm has an entirely different purpose, and serves as an object-lesson to induce the ordinary cultivator to incorporate into his farm practice the teaching of the station. No difficulty has been found in inducing a cultivator to lend a suitable piece of land. This should not be larger than the purpose demands and which the assistant in charge can efficiently manage; a small area carefully cultivated is much better than a larger area inefficiently managed. In some cases, with a thoroughly keen and efficient cultivator, it is safe to rely upon him to supply the bullocks, labour and other requirements, but in most cases it is much better for the assistant to be as independent as possible of local assistance and to supply him with his own bullocks and implements, and with funds to employ the requisite labour; otherwise the demonstration plot is apt to be neglected by the cultivator until the rest of his land has received his attention. An agreement is made with the cultivator for the use of his land, either by payment of a rent or by a share of the produce. Several demonstration farms started in these Provinces have failed to answer the purpose for which they were intended. In some cases they have failed, as they tried to demonstrate what remained to be proved, *e.g.*, that cotton and juar can be profitably grown in the rice tract. In other cases the failure was due to bad management, the assistant in charge having insufficient practical experience of cultivation, even if possessed of fair theoretical knowledge. This is the greatest difficulty that the department has to cope with at the present time; assistants are employed who have not been brought up on the land, and who are not, therefore, in sympathy with their work. Even when supervised by more highly qualified men, their work is not always satisfactory, for, not knowing when the simple cultural operations are properly performed, their supervision is futile. In the past, for lack of sufficient supervision, these men have been left to do things on their own initiative, and the result has been that under their management demonstration farms have

sometimes failed in their purpose owing to a small mistake in practical working. No assistant should be given a demonstration farm until it is certain that he has a thorough practical knowledge of the work entrusted to him. With more careful supervision and reliable experimental results to work upon, the demonstration farms started in Chhattisgarh last year proved successful. The objects aimed at were (1) to substitute the system of transplanting paddy for the present broadcast sowings, (2) to induce cultivators to utilize to the best advantage the irrigation water lately made available by the construction of Goverment reservoirs, (3) to grow a second crop after early and medium paddy, and (4) to demonstrate the method of eradicating *kans* grass by means of Ransome's turnwrest plough. A distinct measure of success has been achieved, and the malguzars and cultivators concerned, who at first were apathetic, are now most anxious that these farms should be continued in their villages for another year, so that they may learn still more of the new methods being taught by the agricultural department, whilst applications have been received from several villages to start similar farms. The department has thus gained their confidence in its desire to benefit them and in its power to do so. The outturns of paddy from the transplanted fields of the demonstration farms and from the adjoining fields of the cultivators, sown broadcast, are shown below :—

	Outturn of paddy in lbs. per acre.	
	Transplanted by the Department.	Broadcasted by cultivators.
Jageshwar Farm	3,940	2,450
Jawaibandha Farm	1,690	600
Kholar Farm	2,880	1,272

Even this large increase due to transplanting does not fairly represent the total value of this demonstration work to the cultivators, for they also followed our example and irrigated their paddy for the first time this year. The cultivators of the villages concerned have thoroughly appreciated the value of these

farms, and the agricultural department has risen considerably in their estimation, so that this year we confidently hope that hundreds of acres will be transplanted where transplanting was unknown before, and this in a tract where the cultivators are notably lazy and slow to adopt improvements. They have already followed our example in transplanting small areas and in irrigating their wheat. The success of these farms was due to the fact that the scheme was carefully devised and the work efficiently supervised by a thoroughly practical superintendent under proper control. The results obtained appeal all the more to the cultivators, seeing that the manure and implements, with the exception of the turnwrest plough used for eradicating *kans*, were exactly the same as those used by themselves, so that the results are due to one varying factor in each case.

Seed farms and seed selection form a part of the work of the agricultural department which readily recommends itself to the cultivator. The cotton seed farms established in these Provinces have been successful. The cultivators recognize the advantage of using good seed, and a few have already started to imitate the seed farms in giving more attention to the cultivation of the plot intended for seed, to the spacing of the plants, to the selection of the seed and to the ginning of the cotton. They show, too, a preference for certain strains of seed. In one case the proprietor has taken into his regular employ the assistant who was in charge of the seed farm. After two or three years' careful supervision it will be possible to withdraw the agricultural assistants in charge of these farms, and to leave the owners to manage them as private seed farms. The department will still continue to supply the owners with selected seed for each year's sowing and to give them the benefit of its advice. The owners will be made to feel that they and the department are working in co-operation for the common weal. They will be requested to inspect the experimental stations from time to time and to see the whole scheme of seed selection carried on at these centres, while officers of the department will inspect and advise them in the management of their seed farms. In the course of a few

years it is not too much to expect that in these Provinces there will be several private seed farms where pure and improved cotton seed can be obtained, and where, too, the use of new manures and new varieties of cotton tested at the experiment stations can be demonstrated to neighbouring cultivators.

The agricultural stations themselves also serve the purpose of demonstrating to the ryots of the tract experimental work of proved value, including the use of improved agricultural machinery. The usefulness of a station in this respect depends very largely on the superintendent in charge. A practical man, who shows tact and sympathy in welcoming visitors, will induce many to come to the station. A visitor generally comes with the intention of seeing one particular experiment, or it may be one particular machine in which he is interested. It is advisable, therefore, to concentrate his attention on the results of one or two experiments in which he is specially interested, rather than to confound him by attempting to explain all the lines of work in progress. If, as a member of one of the District Agricultural Associations, he has been entrusted with one of the co-operative experiments being carried out by his association, he is anxious to compare the results of the station with his own, and he will often declare with some degree of pride that the crop at the station falls short of his own. This department always holds the meetings of the District Agricultural Association at the stations in the case of districts in which stations have been established. In other districts, such meetings will be held at a suitable demonstration or seed farm, whenever it is available. When the meetings are held at the stations, arrangements are made to work suitable foreign agricultural machinery and implements. The members are also shown such of the experimental series as are likely to be of some educational value to them. At other times leading cultivators, who have been paying special attention to one particular crop or manure, are asked to visit the station to compare their results with those obtained there. By paying attention to such points as these, much can be done to make an agricultural station popular, and to rouse the interest of the better class of cultivators in its work.

A Cattle-breeding Farm run by the Agricultural Department can also be made a most useful object-lesson in the improvement of a breed by selection. The cultivator recognizes that the scheme for the improvement of his animals is based on the same principle as that for the improvement of his seed, and that in each case the aim is to produce the best of its kind. The work of the Nagpur Cattle-breeding Farm is duly appreciated, and the demand for the loan of bulls far exceeds the supply available for distribution. On the other hand, the Hoshangabad Cattle-breeding Farm has not been so successful, because the stock is not of the best quality and of the exact stamp desired by the cultivators. It was started without sufficient enquiry into the local conditions and without sufficient effort to secure the right type of animal. Religious sentiment, combined with a knowledge of the fact that his cattle are deteriorating in quality, induces the ryot of the Central Provinces to look with favour on any scheme that makes for the improvement of his stock.

The demand for agricultural assistants as managers of Court of Wards estates affords another opportunity of bringing the results of the experimental work of the stations to the notice of cultivators. But as in the case of demonstration farms, it is essential to frame a complete scheme for such work, which the manager should not be allowed to exceed, to decide what improved methods of tillage, what manures, what system of seed selection and the like should be permitted with due regard to the local conditions. Here, again, the great difficulty is to secure competent candidates for such posts. In some cases the managers supplied for such estates by this department have proved unsatisfactory, being unpractical, lacking in initiative and therefore incapable of performing satisfactorily the duties of an independent charge. Their one idea is generally to imitate the experiment stations, particularly in purchasing foreign agricultural machinery at an extravagant cost. They lack the money-making instinct of the true farmer. In future this department will supervise the work of all its assistants thus employed, and advise them to follow the teaching of the stations only as far as it is applicable to estates run on commercial lines.

By exhibiting agricultural machinery and farm products at shows, fairs and exhibitions, the work of the department can be brought to the notice of a large body of cultivators who are not otherwise accessible. By combining popular lectures on the exhibits with practical demonstrations of each, much good work can be done. This requires to be arranged on a systematic plan in order to secure that the exhibits and lectures are suited to the tract served by the show. The exhibits of farm produce should be neatly arranged in sufficiently large quantities to allow of their being handled by interested parties. It must always be remembered that nine-tenths of the cultivators never read, and that their minds are not trained to assimilate abstract ideas. They are children of nature, and as such get all their impressions from the concrete. The exhibits should, therefore, be arranged so as to be an intelligible and instructive lesson to the ordinary illiterate ryot. The lecturer should, therefore, carry with him a small travelling museum of exhibits to illustrate his lecture. This department has started on these lines to prepare lectures and exhibits suitable for the different tracts. The more important shows and fairs of each tract will in future be attended by the superintendent of the station of that tract, or by some higher official. The superintendent will be supplied from head-quarters with a copy of the lectures that are to be delivered and the necessary museum of exhibits to illustrate the same. In the cotton tract the latter includes bolls of the different varieties of cotton recommended for the tract mounted on cardboard together with those of the varieties already grown locally; on a second sheet the lint is mounted so as to show their relative lengths; on a third is shown the life-history of the stem borer and an actual plant killed by the same, with the help of which the lecturer will explain the remedies and methods of prevention. Cotton boll-worm and cotton wilt disease are similarly illustrated. The artificial manures recommended for cotton are also exhibited along with bags of uncleaned cotton to show the relative outturns of unmanured land and land to which these fertilizers have been applied. At exhibitions the exhibits would be more varied

and on a much larger scale, and many of the experiments that have given useful results at the stations can be graphically illustrated there by pot cultures.

Certain kinds of demonstration work can be effectively carried out by means of an itinerary staff. Here, again, the work is almost sure to prove futile unless precautions be taken to employ the right class of men for the work and to make all the arrangements beforehand, by fixing definite centres and definite dates for the demonstrations and by securing the assistance of the District Officer in intimating the same to the cultivators. Good work has been done on these lines by demonstrating the method of pickling juar to prevent smut. The assistants deliver short addresses at each centre, in which they explain the advantage of using this fungicide, and then proceed to give a practical demonstration of the method of applying it to the seed. Several cultivators are thoroughly taught the process, and are then given free of cost sufficient copper sulphate required to pickle the quantity of juar seed which each intends to sow. About 8 cwts. of copper sulphate were given out in this way last year or sufficient to pickle about 200,000 lbs. of seed. The department has successfully demonstrated this process for several years, and its advantages have been so fully recognized that it has become a regular practice in certain parts of the juar tract. Successful work on similar lines has been done by sending assistants on tour with selected new machines and implements, which we believe to be suitable for the tract. Here also it is necessary to frame a definite programme with fixed centres, such as large villages where bazars are held, where the assistant can stay and work his machines for some days, rather than wander about to a new village each day. In this way a considerable demand has arisen for some useful machines, such as winnowers and fodder-cutters. A register of purchasers should be maintained, and the department should ascertain from time to time whether the machine is working satisfactorily and should assist in effecting any necessary repairs. Failure has resulted in some cases, where the purchaser has not known how to work the machine properly, and

it is now the practice to try and induce a purchaser to send a man to the agricultural station to be taught the practical working of the implements that he desires to purchase. This is very necessary in the case of foreign ploughs, which are sometimes left useless in a village, not because the plough is unsuitable, but because the purchaser has not learnt the proper method of working it.

The school gardens should, to some extent, at least, be the means of bringing the young mind into touch with nature, and of arousing his interest in plant-growth. Nature studies should form a fundamental part in the education of every child so as to teach him to observe closely and to reason accurately from data gained by observation. Nature study brings the child face to face with real things, and tends in this case to give his mind an intelligent bent towards cultivation and for the assimilation, later, of such useful scientific work as the stations may turn out for his farm practice. As the success of the scheme depends very largely on the teachers in charge, they are put through a six months' course at the Agricultural College, where they are taught the rudiments of theoretical agriculture in the class room and on the Nagpur Farm, sufficient to enable them to teach intelligently the agricultural lessons included in the School Readers. The system of elementary rural education has a most important bearing on the future of agricultural improvement.

An important departure was made six years ago by starting at the Nagpur Agricultural College a one year's course in practical agriculture for training the sons of farmers. The teaching is given in the vernacular, and is almost wholly practical work on the farm with a minimum of lectures and book-work. At the outset it was found very difficult to attract the right stamp of student, although scholarships were freely given by the District Councils. Some of the students were the sons of petty traders or officials who had failed in other attempts to earn a livelihood, who had no connection with, or liking for the land, but who hoped ultimately to get some employment and at least to be

supported in the meantime by scholarships. The importance of a careful selection of the students cannot be over-estimated. A few sons of cultivators were attracted with a real desire to learn something connected with their profession, and in such cases some measure of success has been secured, as was shown by an enquiry into the work that they were doing in their villages after they had left the College. One important lesson learned is, that it is most desirable to try and keep in touch with the students after they have finished their course, to encourage them to write and explain what they are trying, to advise them upon any difficulties that they experience, and to visit them in their homes when occasion offers. Some are the keenest members of their District Agricultural Association.

By personal intercourse between officers of the department and leading cultivators, much can be done to increase their confidence in the department and their interest in the work of the stations. Requests for information and advice should be encouraged in every possible way, for amidst much chaff there is often a little good grain. Everything possible should be done, also, to get District Officers to co-operate with the department in carrying out its demonstration work in the districts. If the department is doing its duty, there will be a large amount of unofficial correspondence between its officers and cultivators and the district staff.

The formation of agricultural associations has proved a most useful means of getting the best class of cultivators to co-operate with the department. In the Central Provinces the district is the best unit for which to form an association. Each district should have its own association, the members of which should be the leading cultivators, and a few Government officers who are keen on agricultural improvement, the District Officer being President. In forming such an association, considerable discretion is necessary in order to secure as members the right type of men from among the cultivating class. The men selected should be cultivators who take an intelligent interest in supervising their own cultivation and who are willing to undertake

actual tests of suggested improvements. They should be men of sufficient intelligence to understand simple instructions and to carry them out. The number of members should not be large, but each should be a willing worker and not merely a talker. The District Agricultural Associations started in these Provinces six years ago, have in most cases made satisfactory progress. Among the members will be found the most progressive farmers in each district, men who are anxious to learn and to experiment. The meetings, which are held twice a year to suit the *kharif* and *rabi* seasons, are attended by the Director or one of the Deputy Directors of Agriculture. The results of the past season's tests are discussed and a programme arranged for the next season's work. An officer of the Agricultural Department usually delivers an address describing such experimental work of the stations as may be of some practical use to the members. The members are asked to give their own experience on the particular subject dealt with. New manures and new varieties of seed recommended by the stations are distributed free of cost to the members willing to test them, and they are requested to report the results obtained at the next meeting of their association. To facilitate the writing of this report, forms are furnished, in which the member enters his observation as to the growth and yield of each variety tested, the increase due to the manures and the like. Leaflets written in the vernaculars, giving directions as to how the manure is to be applied and how to grow the crop that is to be tested, are also distributed. The members then carry out these experiments in their several villages. This kind of co-operative work has not yet had time to produce results of much value, but we believe that it may prove most useful as a means of demonstrating to the more backward cultivators the use of new methods, new varieties of seed and new manures ; and the plots on which they are successful, in the case of trials with a new variety, may well become centres for the distribution of the seed to neighbouring cultivators. Indeed, the District Agricultural Associations have proved to be much the best means of distributing new and selected seed which

generally receives a fair trial by the members. An instance of successful work in this line is the introduction of the variety of early ripening *tur* grown in the south of the Provinces to the northern districts, as it escapes the frost which sometimes causes great loss to the late ripening variety locally grown. Seed distribution has largely increased of late, and there is a large and increasing demand by cultivators for improved seed, which the department is endeavouring to meet.

An agricultural paper published in the vernacular can be made a most useful method of disseminating among its readers important experimental results obtained at the stations. It should be up to date, thoroughly practical, and should deal with the immediate needs and interests of the cultivator. It should contain popular statements of the work of the station, with directions to enable cultivators to apply them in their practical work on the farms. Purely scientific articles should never find a place in its pages, for the cultivator does not understand them. In editing such a paper for distribution among cultivators, the translation from English into the vernacular requires to be carefully made. If the work is left to a man who has not been brought up on the land, he often fails to give the meaning of the information which you wish to convey and, being ignorant of local agricultural terms, he gets over the difficulty to his own satisfaction by a free use of Sanskrit which is unintelligible to the villager. The language must be that of the people and not of the court. Such a paper can also be made a most useful medium for advertising improved strains of seed, agricultural machinery and other things for sale at the stations; while by introducing a "query and answer" column the readers are encouraged to ask the department for advice which, when given in this way, often saves the trouble of having to reply in the same strain to several different individuals. The Agricultural Gazette published monthly in Hindi, Marathi and English in these Provinces, has been a decided success. There are already 2,500 subscribers, but this is no measure of the circulation of its contents as, in villages in which only one Gazette is received, it

is the common practice for the *Pandit* of the same to read it aloud to his fellows. With the increasing number of persons taught to read and write, there is a great dearth of reading matter in the village, so that a monthly magazine is a real boon to many.

These in brief are the steps that are being taken to get the results of the stations' work incorporated into the general farm practice of the cultivator. What is required at present is steady work on these lines, perfecting them from time to time in accordance with the dictates of a fuller experience. The work is yet in its infancy and the difficulties in the way of rapid progress are great owing to the paucity and inefficiency of most of the existing agricultural assistants. The better prospects that are now offered to men entering the department should attract men of the right type who, having been brought up on the land, understand the needs of the cultivator and how to meet them ; and who, moreover, inherit as by instinct a sense of the dignity of labour.

THE SUGARCANE BORERS OF BEHAR.*

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INTRODUCTORY.

CANE-GROWING as an industry has assumed great proportions in Behar during the past two or three years and has evidently come to stay. It is therefore of great importance that growers should know what pests attack sugarcane and how best to combat their depredations. Unfortunately, very little has been so far known on the subject, it being one to which apparently too little time has been devoted. It is hoped that the following remarks will have the effect of inducing others who are interested in cane-growing to make further investigations.

It is proposed in this paper principally to give the result of certain observations of Cane Moth Borers in the District of Sarun, with notes of their occurrence in Tirhut. The term 'Mothborer' is used to denote a caterpillar which bores in the tissues of the cane plant and which eventually becomes a moth. For the sake of convenience these insects are here separated into three different types, descriptive of their methods of attacking canes. See Plate XXI. They are :—

1. Shoot-borers, those which enter the cane by tunnelling downwards through the shoot or terminal bud.

* The greater part of this article is the work of Mr. Mackenzie, especially the account of the White Borer and the Green Borer. I have added the results of my work at Pusa and have prepared the illustrations.—H. M.-L.

2. Side-borers, those which enter the cane at the side.
3. Root-borers, those which bore into the roots of the cane.

1. SHOOT-BORERS.

Under this classification are two moths, the White Moth (*Scirpophaga auriflua*), the Black Spotted Moth (*S. monostigma*). Both are essentially white moths (Plate XX, Figs. 3, 5, 10), but the latter has a small black speck on each forewing. The hind end of the body is formed by a tuft of hair which is large in the female moth, and is either buff coloured, or the outer hairs are red, the inner buff. The White Moth is much more numerous and does much more damage than the Black Spotted Moth. The latter is not a serious pest in Behar like the former which there does great damage to sugarcane. In some seasons, favourable to the development of this insect, it is probable that at least 80 per cent. of the cane crop is affected by it. The cane, when affected, ceases to grow. The result is usually so serious that the cultivator should at once adopt remedial measures. In the case of these two particular pests, when a field is badly attacked, the cane has a general appearance of drying up owing to the top shoots, which are the portions attacked by the insect, having quite withered, forming what is known as "dead hearts." If a "dead heart" or withered shoot is pulled out by the hand, it is found quite rotted and has a most offensive smell. If looked at carefully, most probably a number of very small maggots, the larvæ of a very small fly, may be seen in the rotted portion. These are not the cause of the withering of the shoot and consequent damage to the cane. The cause must be sought lower down. Under the description of the "Caterpillar," the manner in which it operates will be described. We propose to discuss the life history of these shoot-borers in detail, beginning with the eggs.

Eggs.—The eggs of both moths are very similar in size, shape and appearance. They are elongate, oval and are usually laid in clusters of from sixty to eighty in number, most often on the under side of the fourth leaf from the top, although they may

be found on almost any leaf. The female moth, when depositing her eggs, covers each one in turn with some of the buff hairs from the anal tuft, the whole forming a compact cluster, buff in colour and measuring about a quarter of an inch long by an eighth of an inch in breadth. These eggmasses are not at all difficult to detect by one who knows where to look for them and what their general appearance is like. (Plate XX, Fig. 2.) The female, if disturbed, during the process of depositing her eggs, will fly off to another leaf, continuing the egg-laying there, and this doubtless accounts for many of the clusters being smaller than others. As the result of observations during some years, it may be stated that the earliest eggs are laid on cane about the first week of March, preferably on young cane planted during the previous October, but also on older cane. Cane planted in January or February is generally too young to attract the moth at so early a stage, and it will generally be found that their attacks on such canes do not become general until the middle or end of March. The eggs usually take from eleven to twelve days to hatch out, as found by observations on moths kept in captivity. In captivity, the eggs are deposited on the second night after the emergence of the moth from its chrysalis. Such eggs laid on the night of 5th March hatched out in twelve days, and some laid on the 8th March in eleven days; therefore, the period of incubation is from ten to twelve days. The white Shoot-borer moth, *S. auriflua*, also affects *munj* grass (*Saccharum ciliare*) and the eggs are also found in great numbers on a grassy reed which grows in rice *jheels*. This, of course, complicates enormously any remedial measures which might be taken for their extinction. It was found, in nearly all cases of eggs deposited on reeds in *jheels*, that minute parasitic wasps kept the pest within reasonable limits.

Caterpillar.—On the first day of emergence these are about $\frac{1}{12}$ of an inch in length, very active little insects with head and thorax shining black, a narrow whitish band between thorax and body above, body reddish brown studded with erect spines or hairs longer than the thickness of the body. On the second day they apparently shed their skins, the head and thorax became reddish

brown, the thorax and body a very pale green with dark dorsal line (pulsating heart), the hairs on the body were few and short, and the length of the larva about one-eighth of an inch. These observations were made from insects hatched in captivity, no observation being possible after the second day owing to their disappearance from the breeding cage. The young larvæ lose very little time after hatching, in boring into the unfurled leaves on terminal shoots of the cane stem; they eat their way through the shoot, the effect of which on the shoot is to produce a great number of small holes or, as they have been described, "shot holes." After penetrating the leaf, they burrow down until they reach the sappy portion of the cane stem from which point the real work of destruction commences. It is a remarkable fact that, although many of the young larvæ penetrate into the growing terminal shoot, only one insect is in possession by the time the sappy portion of the cane is reached. We do not know what happens to all the others, but it would seem reasonable to conclude that being less fortunate or less vigorous, they are forestalled in the race for the stem, and quit that particular shoot for other shoots close by. Probably during this dispersal, many are destroyed by predatory insects and birds, and no doubt parasitic insects also attack them, so that a small proportion of young larvæ survives to damage the cane. If every insect hatched from a cluster of eggs entered growing cane, the results would be dire indeed, for boring by this insect causes the upward growth to stop or the whole plant to die if it is not of vigorous growth. The boring insect eats its way downwards through at least three or four joints from the top or should the joints or nodes be very close together, as often happens, six or even seven internodes may be tunnelled. During this process of boring, a period of some 22 days has elapsed, and the larva meantime has acquired a length of about three-quarters of an inch. The colour of the insect now is a dull creamy white, the intersegments and dorsal streak darker, with a few scattered hairs all over the body; the head is pale yellow. The boring stage in the life of the insect has now been about completed and it is time for it to enter into

the chrysalid stage. With this object it bores at right angles to the original tunnel until it reaches the bark of the cane from which it cuts out a circular section about the size of a No. 2 shot. This section it attaches again to the hole by a gummy substance from its mouth; thus a cover or door is formed through which the perfect insect can later on emerge, and a protection is provided against the inroads of ants or other dangerous insects. During the active period of the borer's life and while boring down into the cane, it covers its retreat with the "frass" or excreted portions of the cane, but when nearing the final stage of its boring it retains a considerable length of the lower portion of its tunnel—about twice its own length—free from such ejections, and this portion it lines with a coating of silk. After having closed up the hole of exit it retires to the further end of the silk-lined chamber, spinning silken partitions at frequent intervals during its retreat, as many as ten or a dozen such being sometimes made. It is thus thoroughly safeguarded against outside danger, and transformation into a chrysalis begins. In this chamber it remains head down and towards the hole of exit, until the pupal stage is complete.

The larva, unlike that of the other moth-borers referred to later, if released from its burrow, is quite incapable of shifting for itself. It is unable to burrow into the ground or hide itself underneath clods on the surface of the soil, and cannot transfer itself to another cane: it is quite a harmless insect. Experiments made by placing it under loose soil in close proximity to a piece of cane have proved that it fails to enter the cane and will die where placed.

The effect of the operations of this borer on young canes is most disastrous. The shoot which has been attacked usually dies, as it is too young to withstand the shock. In old canes, on the other hand, the cane does not die, but all further growth of the sugar-producing stem is entirely stopped and the top six inches of the cane is quite unfit for crushing. The eyes or buds of this portion of the cane throw out long shoots which must detract very considerably from its sugar-producing value. The existence

of these shoots is typical of a cane bored by the White Moth Borer, and the cane exhibits the appearance of having a tuft of green shoots at the top with the withered shoot or "dead heart" in the centre. (Plate XXII.)

Chrysalis.—The chrysalis under ordinary circumstances remains in a motionless state within the silk-lined chamber for a period of from ten to twelve days. The pupa of the male is much smaller than that of the female, the former measuring about half an inch, the latter about three-quarters of an inch. At the expiry of the period mentioned, the moth breaks through the chrysalis case and emerges from the cane. How it gets rid of the intervening partitions and finally makes its exit can only be conjectured as the moth has no apparatus for eating through them. Possibly it forces its way through or scratches through them with its forelegs. The emergence usually takes place about an hour after sunset. (Plate XX, Fig. 17.)

On first emerging, the moth is not perfectly formed, or the wings have still to open out, and probably for fully an hour the moth is unable to fly. Mating takes place the first night and eggs are laid on the second night.

The entire period occupied for one generation from egg to moth will thus be seen to be from about 45 to 50 days, and if we take the period of activity of the pest in cane as from 1st March to end of October or say middle of November, we shall not be far wrong in considering that there are from five to six generations of the moth during the year. Cane planted early in October had the caterpillar in it in November, but it was found that these caterpillars, instead of going through the usual transformation into the chrysalis, remained within the cane in a dormant state until the following February, when instead of going on feeding again they became chrysalides, and after the normal period of pupation emerged as moths to begin the fresh cycle of their existence. This is the normal method of hibernation, and in the ripening cane at Pusa not cut till January or February, abundance of dormant larvæ were found.

Remedies.—The planter is doubtless interested in the fact that the borers attack his cane, but his chief interest lies in preventing attacks by these insects. To prevent attack altogether is, so far as is known at present, quite impossible, but a very great deal can be done to mitigate the severity of the attack, if prompt measures are used at the commencement. These consist of capturing any moths found sitting about on the leaves, the hand picking of the egg clusters when the cane is about a foot to eighteen inches high and the rigid cutting out of "dead hearts." The egg clusters are really not difficult of detection, and a smart coolie can keep about two acres under check if he goes over this area daily until the cane becomes tall and leafy. The following history of a two-acre plot of *shamshara* cane planted on 29th October 1904 with a view to the observation of insect pests illustrates the beneficial results which can be obtained by egg-picking. The cane germinated freely, and was apparently free from all insect attack until on 9th February 1905 numbers of the White Shoot-Borer Moth were observed on the plants. The cane on account of the cold had previously made but little growth. Killing the moth by hand was at once resorted to, and daily for about ten days, hundreds of the moths were destroyed. At this time, egg clusters were noticed in considerable numbers and to cope with these, one small but sharp coolie boy was put in charge. This little fellow, working assiduously from morn till evening, had, at the end of each day's work, collected several buckets full of the eggs. The leaf on which the eggs were deposited was plucked and the portion on which the eggs were situated was placed in the pail. The results of the day's work were burnt in the evening. About a fortnight after the first moths were observed, indications of "dead hearts" became apparent, and the cutting out of these, at or below ground level, also came within the duty of our small coolie. These latter were collected in small heaps, and underwent the same treatment every evening as the eggs. Daily, from 24th February until the middle of April, the operation of egg-picking and cutting out of "dead hearts" went

on, until the canes became so tall and leafy that detecting either eggs or "dead hearts" became very difficult. Every cane seen to be affected was cut out and the appearance of the crop represented only a 30 per cent. germination. Often the old factory *Jemadar* pleaded for a cessation of what he considered to be sheer and wanton destruction on the part of the over-zealous *sahib*, but it soon became self-evident even to the happy-go-lucky native servant, that the cutting out had encouraged tillering, several shoots had sprung up where there was only one before. Throughout the following rains that particular plot was singularly free from "borer," and on 1st November was cut down to provide seed for November planting elsewhere. The weight of stripped and topped cane taken off this two-acre plot was 38·6 tons, of which only ·07 tons were rejected as being unfit for seed, all bored or otherwise injured portions being carefully eliminated. The remaining and adjacent portion of this field, some nine acres, was planted out with *shamshara* cane in the month of March under conditions of cultivation similar to the two-acre plot, but there was no collecting of eggs or cutting out of "dead hearts." The outturn of stripped and topped cane was only 12·4 tons per acre as against 19·3 tons per acre from the experimental plot. There is no doubt that the treatment produced beneficial results.

"Dead hearts" in young cane can be cut out until the cane is about three feet high, afterwards it is difficult or impracticable to continue the work. The shoot should be cut at a point below where the "borer is at work; this is easily ascertained, for, if the cut is made above that point, the portion already bored will be quite apparent and the shoot should be cut lower down until it is certain that the borer has been cut off. The three chief methods then open to the cane cultivator are :—

First, killing of moths found resting on the cane plants.

Second, hand-picking of the egg clusters.

Third, cutting out of all "dead hearts."

The destruction of useless canes by burning is important as they may contain borers, but it is a wasteful practice to burn the

trash (dry leaves, etc.) as this stuff does not harbour cane insect pests. It is better to use the trash as litter for cattle or put it in a compost pit.

There is one other point of importance respecting this pest: it spends the winter in the caterpillar state in the top of the cane, and such a cane can be known by the number of shoots that have grown out on each side at the top, forming a bunchy top. Where cane is being cut from November to February the destruction of these bunchy tops should be rigidly carried out since every one allowed to stand over till late in February may mean a moth hatched out; such tops may be fed to cattle, or chaffed up or put in a compost pit; they must never be allowed to lie in the field or be stacked, since the moths would then have no difficulty in hatching out and laying eggs. (The habits of *S. monostigma* are so identical with that of *S. auriflua* that a separate description is not necessary.)

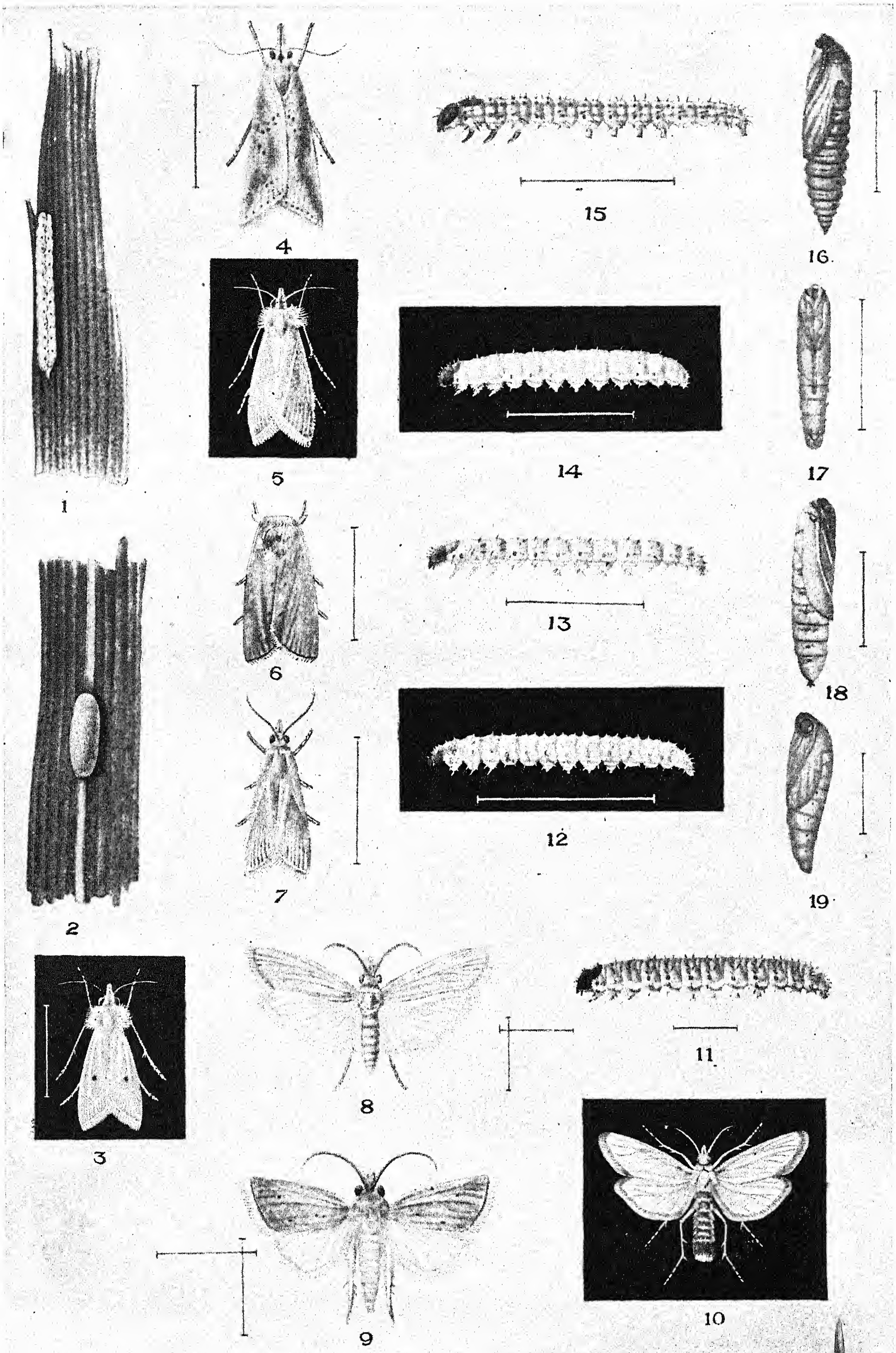
In addition to these remedies, nature has provided one which is the most beneficial of all. This is the attack of parasites on both eggs and larvæ. Were it not for the check imposed by these parasites, cane-growing would be out of the question. Minute parasite wasps deposit their eggs in the eggs of the moth and in course of time, instead of young larvæ of boring moths being produced, perfect wasps emerge. Large parasitic wasps (*Braconidæ* and *Ichneumonidæ*) deposit their eggs in the bodies of the borer larvæ, and thus keep them in check.

The following suggestion was made in "Indian Insect Pests" in connection with the collecting of egg clusters. "These eggs should not be destroyed but be put in a tray or dish standing in a larger dish of water or into a tray with a gutter of water round the rim. The parasites hatch out and fly away; the caterpillars that hatch, die being unable to cross the water. In this way the parasite is not destroyed, but continues to do its good work in the canes."

1. SIDE-BORERS.

Four different species of Side-borers have been recorded, *viz.*, the common Moth-borer (*Chilo simplex*), the Gold Fringed Moth-

PLATE XX.



CANE BORERS.

borer (*Chilo auricilia*), the Pink Borer (*Nonagria uniformis*), the Green Borer (*Anerastia ablutella*). Of these, the first is usually greatly in excess of the second in numbers and the third not very plentiful, while the fourth is pretty common. Although none of these are so numerous as the Shoot-boring Moth already described, still they are a very real and deadly pest to cane.

THE MOTH-BORER.

(*Chilo simplex.*)

For all practical purposes a description of the mode of operation of this species will suffice for that of *Chilo auricilia*, as in so far as cane is concerned, their methods are identical.

Eggs.—The eggs of both species have been found in the cane fields at Pusa but only in small number. (In captivity, both species have deposited their eggs freely, but this does not help us to discover them in the field; they occur freely on the cane leaves in Surat and Poona (Plate XX, Fig. 1).) The reader should consult the article on this pest in this Journal, Vol. I, No. 2, page 97.

Caterpillar.—The young caterpillar, on emerging from the eggs, may enter the young cane shoots when from eighteen inches to two feet high either just above ground level or at any point higher up to within say a foot from the top of the shoot. In the former case it will tunnel its way upwards until it has consumed all the sappy portions of the stem when it will leave that and enter into an adjacent one. In the latter case it will bore down until it reaches the root stock and will pass from shoot to shoot until the period for its pupation arrives. At this stage it bores laterally, cutting a small round hole of exit in the rind which it completely closes up with a web of silk. It then retires within the burrow and undergoes the chrysalis stage. The hole of exit is always above ground level. *Chilo auricilia*, unlike other identified cane-borers, allows others of its own species to occupy the same burrow, as many as three having been found in the same

tunnel. Later on when the cane grows taller, many separate burrows, occupied by different borers of this species, are frequently met with. The description given above refers to the cane in its earlier stage of growth and before defined nodes appear. In the earlier stages the boring results in a "dead heart" as in the case of *Scirpophaga auriflua*, and on plucking out the dried tip one can almost always tell by a casual examination of it which of the two borers have been at work. In the case of "*Chilo*" no punctures showing the entry of the insect will be found, whereas in the case of "*Scirpophaga*," as a rule, numerous small holes will be found showing where the young larva has penetrated into the growing tip prior to tunnelling its way down the stem. Later on, when nodes have appeared in the cane, the attacks of "*Chilo*" show no signs of a "dead heart," and it is likely that the progress of growth of the affected cane, although retarded, is not stopped.

The larvæ tunnel in the old canes in a very distinct fashion from that of *Scirpophaga*. It is not uncommon to find them in the shoot above the cane, feeding much in the same way as does *Scirpophaga*, not destroying the growing point or killing that shoot; in this case they frequently eat downwards, but they come in and out of the cane, eat round it, and do not behave in the same uniform manner that marks the *Scirpophaga* larva. More larvæ were found in the cane, in the internodes, at any point above ground; the larva eats into the cane, feeds inside and may destroy a few joints, or may come out and go in again elsewhere. It is common to find several holes made by one larva. When the larva becomes full fed (Plate XX, Fig. 15), it eats a hole to the outside, spins a few threads across and retires to transform to the pupa. (Plate XX, Fig. 16.)

Chrysalis.—The period occupied in the chrysalis stage is from ten to twelve days in cool weather, though only six to seven in hot weather. The moth emerges through the hole of exit previously prepared by the larva.

Moth.—The moth is wholly nocturnal and does not rest openly on plants in the open, as does the White moth. It is

therefore practically never seen and will only be found if a light is placed in the field. (Plate XX, Fig. 4.)

Hibernation.—Normally hibernation occurs as a resting caterpillar or a chrysalis in cane or some other food plant. In Behar, the moth comes out late in February or early March and also in June. The caterpillar lives in rice, maize and various millets as well as in cane, and hibernates in any of these crops which may be standing. It is noticeable that when early maize is grown, enormous numbers of the caterpillars often occur in it, not boring in the stems but living in the green shoots or in the male flowers. From observations at Pusa, it is clear that the maize crop is very much more infested than is cane while the maize stands and this is probably the reason why this borer is so much less destructive than it is in Bombay for instance. There is much less loss to cane from this pest in Behar, and there is a much greater proportion of it in maize and similar crops, where it is not really very destructive.

Remedies.—Until the eggs can be located, there is little use suggesting gathering them, so that the next best method is cutting out "dead hearts" and burning them in the early stage of the cane. Later on this cannot be done, without incurring very great loss of cane. To exterminate the pest altogether is absolutely out of one's power, for "*Chilo*" lives, moves and has its being as much in maize and jowar (*Sorghum vulgare*), etc., as in the cane. The fodder of these crops is stored in stacks, and in these the caterpillar which is hibernating, finds its home throughout the cold weather, emerging in great numbers as moths whenever the weather begins to get warm. It has been suggested, that burning the tops of the cane during the crushing season is beneficial as a remedy for "*Chilo*," but this cannot be, for "*Chilo*" is not found in the tops at that stage of the cane's existence.

Pink Borer.

(*Nonagria uniformis.*)

Another Side-borer which commits considerable damage is the caterpillar of a moth previously undescribed, to which the

name of *Nonagria uniformis* has been given by Mr. Dudgeon. This is the largest of all the cane borers referred to in this paper.

Eggs.—We have not discovered where the mother moth lays her eggs in a state of nature, although in captivity the eggs are freely deposited on the leaves of cane. In wheat and rice the eggs are laid in clusters on the leaves near the stem; they are round white eggs, not flattened as are the eggs of the ordinary borer.

Larvæ.—The caterpillar is most easily recognised by its colour; it is a smooth caterpillar, with few short hairs, a brown head and a distinctly pink tinge over the whole body. It grows to a length of $1\frac{1}{2}$ inches and has no brown spots on it (Plate XX, Fig. 13) as has the caterpillar of the previous borer (*Chilo simplex*). The newly hatched caterpillar enters the young cane shoot or stem at or just above ground level, tunnelling its way upwards for a considerable distance, then returning to continue its burrow downwards, stopping short, however, at the point where the shoot springs from the parent sett. It follows this routine in several canes until it is fully fed, when it leaves its tunnel within the cane, and establishes itself between the cane stem and its outer sheathing or leaf. In this position it weaves around itself a casing consisting of small portions of the cane finally shredded and minute pieces of the stem itself, which the insect gnaws into fine particles resembling sawdust. Within this casing it pupates. Although when actively feeding, each caterpillar appears to monopolize a stem to itself, several will congregate within the same sheathing leaf and pupate in close proximity to each other. We found larvæ of this moth as early as the 5th of May, and specimens were constantly found up to 27th August. Diligent search would probably determine that they operate much earlier and later than the dates given. They have been found in all varieties of cane grown in Behar.

Chrysalis.—The chrysalis stage covers a period of nine to ten days, the moth emerging at the upper end of the enveloping cane leaf. (Plate XX, Fig. 18.)

Though found in cane, this borer is far more frequent in other crops and it would be found abundantly in cane probably only when these were not grown. It is very abundant sometimes in rice in the late rains and early cold weather; in January the moth comes out and lays eggs on wheat, which is attacked freely in February. The insect then attacks the cane and has later been found in maize, jowar (*Sorghum vulgare*), other millets and guinea grass. Its period for attacking cane may then be a short one, where not much cane is grown in comparison with other crops, and its importance in cane is usually much less than its importance as a pest of wheat and rice.

Green Borer.

(*Anerastia ablutella.*)

This is another Side-borer which was found in great numbers when the young cane was about three weeks to a month above the ground. It has been identified by Mr. Dudgeon as *Anerastia ablutella*, Zell. We have not yet discovered where the moth lays its eggs, but specimens of the caterpillars were taken from the young canes continually from 1st April to 20th May.

The young caterpillar enters the cane shoot just below the surface of the ground, and first of all eats its way up the stem for about three inches and then tunnels down until it reaches the juncture of the stem with the planted cane, or should by this time the attacked stem be showing signs of joints, the larva will stop short at the first joint, and as a rule never penetrate through the joint. It then leaves that shoot and enters an adjacent one and goes on feeding for probably a period of three weeks. Larvæ about a week old were collected on the 1st of April. They became moths on the 22nd April. It is pretty safe to reckon 21 days for the larval stage and eight to nine days for the pupal. This borer leaves the cane and pupates in the ground; therefore it is difficult to determine when the latter stage is entered. The mature larva weaves in the ground a small round cocoon of silk

to the outside of which it attaches small particles of soil. This cocoon measures about $\frac{3}{8}$ of an inch and would be quite indiscernible to an ordinary observer. The usual "dead heart" is the sign that the cane has been attacked, and the only remedy so far known is cutting out the affected stems. The caterpillar is very active in its movements when out of the cane, and if left to itself, will, in a second or two, disappear under the ground. It is bright green in colour (Plate XX, Fig. 11), and cannot be mistaken for any of the other known cane borers, and measures about $\frac{3}{4}$ of an inch. It would appear that the larvæ of *Anerastia ablutella* runs through only two generations in the year at least in cane, but further investigation on this point is required. During the greater part of May and from that time on to the 27th of August the larvæ remained in a lethargic state down in the roots of the cane. It was, therefore, concluded that they were passing through a period of dormancy. Specimens of the caterpillar were also kept in captivity in the cane roots dug from the field, and these remained in this dormant state, and as larvæ until the following February when they pupated and bred out into moths in March. No insect has been observed as parasitic on the green borer. This pest has only been observed in Behar in a cane called *Langura*, which was imported from the United Provinces. Irrigation kills quite a large proportion of those which happen to be at the time, either feeding in the cane stem below the water level or in the ground, while passing from one cane stem into another.

3. ROOT-BORER.

(POLYOCHA SACCHARELLA.)

Perhaps the most deadly of all the cane borers is one which attacks the roots. Most fortunately they do not appear to be numerous as either the White borer or the ordinary borer, but nevertheless this insect is responsible for a great amount of damage attributed to white ants and other causes. The body of this caterpillar is white with intersegmental rings darker—the head light brown—length from $\frac{3}{4}''$ to $1''$. (Plate XX, Fig. 12.)

This caterpillar, like that of the other cane borers, would appear to become active in cane from about the time the cane is three weeks to a month old, generally about the end of March or beginning of April. It is, of course, difficult to say with any degree of certainty, seeing that it confines its operations entirely to the roots of the cane, and consequently its attack is not detected so soon as that of the other borers. The earliest specimens were obtained on 24th April. From that period, right on throughout the hot weather and rains specimens were taken and all of them appeared to be actively operating on the cane roots. On 25th November specimens were collected which at the time had every appearance of hibernating and afterwards proved to be so; for they did not emerge as moths until 20th to 22nd of the following April, during the whole of which period they were not feeding. They commence their life by boring into the cane stem low down, from which point they pass into the roots, where they spend the remainder of their existence as larvæ. As many as eight of these borers have been taken from the roots of one root stock. The result of the attack of this pest is that in a great many cases the whole stool dries up, or at any rate has a stunted or shrivelled up appearance. When the larva is about to pupate, it generally selects a dried-up stem standing perhaps a few inches above ground and the dried-up terminal shoot of which has fallen off, up through which it burrows to the end; at this point it weaves a sort of dome or tube of silk to the outside of which it attaches portions of the frass (borings from the tunnelled stem). This dome stands up from the end of the stem about an inch to 1¼ inches, the top being closed. The larva then retires down into the roots and when in due course the moth emerges, it makes its way out by eating through the upper end of the dome.

The effect of a bad attack of root-borer is to dry up the whole of the affected plant. From the period at which the attack commences, the shoots assume a sickly and stunted appearance and as a rule no canes are ever formed, but even should

they be, these will ultimately, and long before they are fit for the mill, entirely dry up. This borer has been found to be far more abundant in some localities than in others. In Pusa, newly planted canes have not been much attacked, but some thick canes, kept as ratoons, suffered very severely. This will readily be understood as the insects hibernate in the shoots and go on attacking the ratoons when the warm weather comes; as shoots are formed, they are destroyed and the work of this borer can usually be detected easily by digging up ratoon shoots that are not thriving and cutting into the underground parts of the shoots. It is unfortunately difficult to distinguish the work of this insect from that of the other root eating insects, notably the weevil and the cockchafer, which both attack cane below ground, unless one finds this caterpillar or its chrysalid habitation.

This borer is not yet known to attack anything but cane, and cane planters will do well to pay attention to it if they find shoots dying off, not as "dead hearts," but wholly and from some point below the soil. There is one important point in the treatment of this borer, and that is, to take up the stools of cane as soon as possible after the canes are cut and either put them in a real compost heap under several inches of earth or burn them outright. When canes are cut before the end of the cold weather, great numbers of root-borers can be destroyed in this way and even in the case of canes cut after February, it is very important and practically the only check.

In the above pages no less than seven distinct insects are referred to. We have refrained from describing moths in detail except in the case of the White borer, because to the ordinary observer, they are so extremely similar. The moths of the common moth-borer (*Chilo simplex*), of the Gold Fringed Borer (*Chilo auricilia*), of the Pink Borer (*Nonagria uniformis*), of the Root-Borer (*Polyocha saccharella*), of the Green Borer (*Anerastia ablutella*), are all the colour of a dry grass stem or a withered cane leaf: the differences between them are shown in the plate, but, for the most part, their recognition depends on characters it is needless to give here. For the planter it is important

to be able to identify the caterpillars, and the following briefly summarises the important points :—

A green caterpillar found in the young canes in April, May, June, is the Green Borer (*Anerastia ablutella*). (Plate XX, Fig. 11.)

A pink caterpillar, found in either the young canes or in the jointed canes is the Pink Borer (*Nonagria uniformis*). (Plate XX, Fig. 13.)

A pure white caterpillar found below the soil level and boring in the underground parts of the shoots is the Root-Borer (*Polyocha saccharella*); it will be found from April to November. (Plate XX, Fig. 12.)

A pure white caterpillar found in the young shoots or in the top only of the jointed cane, and always destroying the apical growing point, is probably the White Borer (*Scirpophaga auriflua*), but may possibly be the Black-spotted Moth Borer (*S. monostigma*). As both work alike, it is immaterial. (Plate XX, Fig. 14.

Finally, a dirty white caterpillar, with either distinct brownish spots or with vague bands of dark colour, found in the young shoots, causing "dead hearts," or in the joints of the canes (not in the top shoot), is either the common borer (*Chilo simplex*) or the Gold Fringed Borer (*Chilo auricilia*); as both work alike and are distinct only in the moth stage, it is immaterial which it is (Plate XX, Fig. 15). The following table may help in summarising the matter clearly; it must not be taken too literally in the case, for instance, of Pink Borer in June.

	White Borer.	Moth Borer.	Green Borer.	Pink Borer.	Root Borer.
January ...	Hibernating in top shoot of cane.	Hibernating	Hibernating	Moths out. Eggs laid on wheat.	Hibernate in soil or cane.
February ...	"	"	"	In wheat	"
March ...	First moths out. Commencement of first attack in young cane.	First moths out. "Dead-hearts" in young cane.	First moths ou	In wheat. Eggs on young canes.	In young canes below ground.
April ...	Causing "dead hearts" in young cane.	Causing "dead hearts" in young cane.	Causing "dead hearts" in young cane.	In young cane	
Ma ...	"	"	"	"	

	White Borer.	Moth Borer.	Green Borer.	Pink Borer.	Root Borer.
June ...	In top shoots of cane.	In cane and other crops if available.	Causing "dead hearts" in young cane.	In cane, guinea grass or other crops.	In cane shoots below ground.
July ...	,,	In cane, maize, janera, etc.	Hibernate as caterpillars in soil.	In cane, maize, etc.	,,
August ...	,,	,,	,,	In rice, cane, maize, etc.	,,
September ...	,,	,,	,,	In rice chiefly.	,,
October ...	,,	,,	,,	,,	,,
November ...	Hibernate as caterpillars in top shoots of cane.	Hibernate as caterpillars in cane, in stubble, in janera stalks, etc.	Hibernate as caterpillars in soil.	,,	Hibernate in soil or in cane shoots.
December ...	,,	,,	,,	Hibernation in rice stubble.	Hibernate.

Conclusion.

We may shortly summarise the treatment of a cane crop in Behar as regards Moth borers, commencing with the planting and including some precautions necessary for other pests.

The plant cane having been cut into setts, the setts are rejected if bored, and if sound, are dipped into either Bordeaux mixture or a cold solution of copper sulphate (bluestone) in water. This checks white ants. The young canes are periodically gone over, all "dead hearts" cut out, all eggmasses collected; the former are destroyed by burning, by being chaffed and fed to cattle or by burying in a compost heap; the latter are taken from the cane field and simply exposed where the parasitic flies can escape or are left in the field in a proper dish or tray surrounded with water. Cutting out "dead hearts" should continue till May or June, egg collecting as long as possible.

If possible, an early crop of maize should be grown to attract the common Moth Borer (*Chilo*), and if this is full of the caterpillars, it should be fed to cattle or treated in some manner that will destroy the caterpillars. When the cane is being cut, all "bushy tops" should be properly dealt with, as containing White Moth Borers: the rejected bored canes which are usually left on

PLATE XXI.

MOTH BORERS IN THE CANE PLANT.

the field as worthless should be collected and properly destroyed; and as soon as possible after cutting, all stumps should be taken out and so dealt with that the Root-Borer will not be able to complete its life. At the same time, it is worth while making certain that the stacked fodder is not a source of danger by breeding Moth borers (*Chilo*), and that the stacks are properly covered in so as to prevent the escape of the insects.

These are the only practical precautions that can be taken against borers, and they are within the reach of every cane grower in Behar. If they are properly carried out, the great loss now sustained from borers will be reduced and the present low yield of cane per acre increased.

EXPLANATION OF PLATES.

PLATE XX.

Fig. 1. Eggmass of Moth Borer (*Chilo simplex*).
,, 2. Eggmass of White Borer (*Scirpophaga auriflua*).
,, 3. Black Spotted Moth (*Scirpophaga monostigma*).
,, 4. Moth Borer (*Chilo simplex*).
,, 5. White Moth Borer (*Scirpophaga auriflua*).
,, 6. Moth of Pink Borer (*Nonagria uniformis*).
,, 7. Moth of Root-Borer (*Polyocha saccharella*).
,, 8. Moth of Green Borer (*Anerastia ablutella*).
,, 9. Moth of Pink Borer (*Nonagria uniformis*).
,, 10. White Moth Borer (*Scirpophaga auriflua*).
,, 11. Green Borer (*Anerastia ablutella*).
,, 12. Root-Borer (*Polyocha saccharella*).
,, 13. Pink Borer (*Nonagria uniformis*).
,, 14. White Borer (*Scirpophaga auriflua*).
,, 15. Common Borer (*Chilo simplex*).
,, 16. Pupa of Moth Borer (*Chilo simplex*).
,, 17. ,, of White Borer (*Scirpophaga auriflua*).
,, 18. ,, of Pink Borer (*Nonagria uniformis*).
,, 19. ,, of Root-Borer (*Polyocha saccharella*).

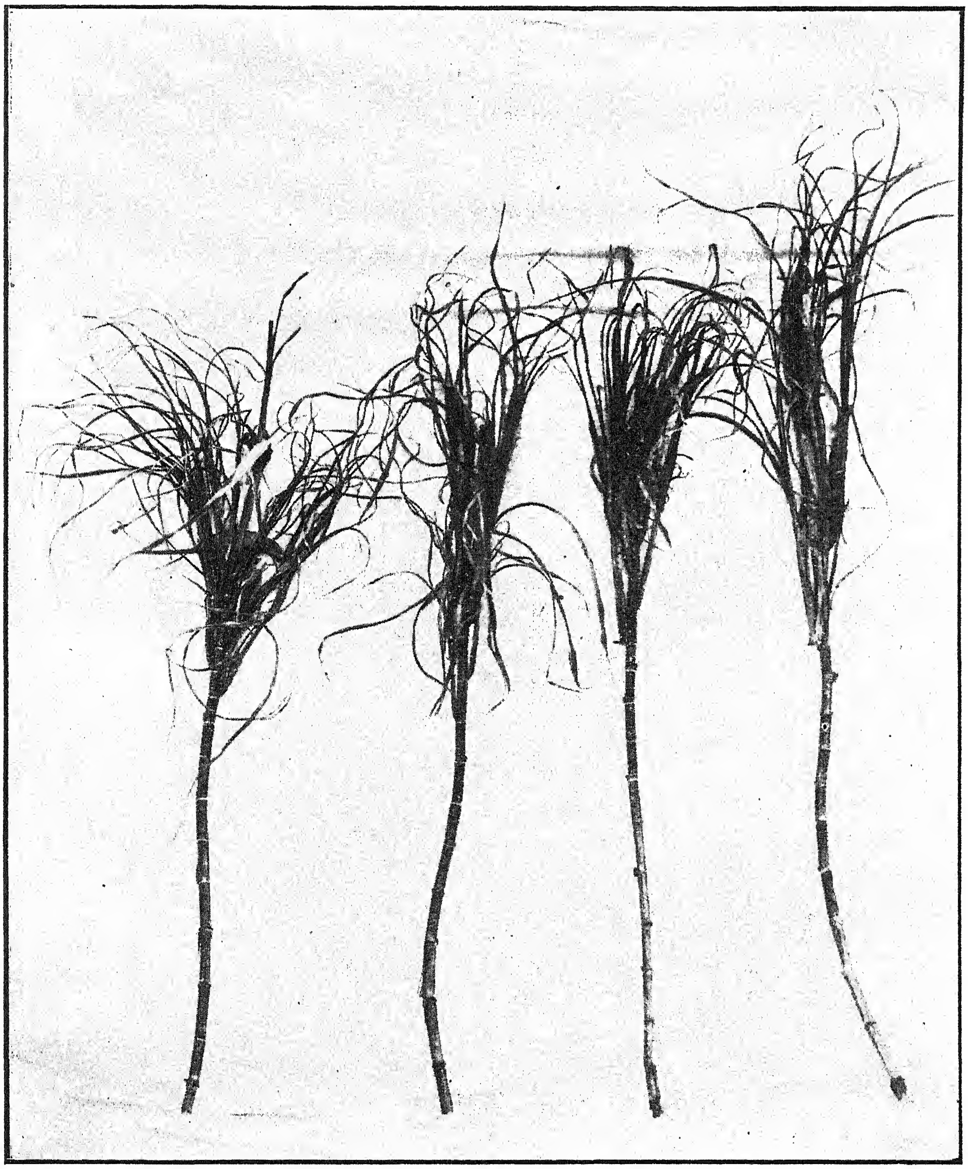
Plate XXI.

Diagram of Cane Plant, showing work of borers in red. 1. Above is the track of the White Borer through the growing point out to the side. 2, 3. The track of two Side-borers in the joints is shown below, these being the Common Borer and the Pink Borer. 4. The track of the Common Borer (*Chilo*) in a shoot, the growing point not specially attacked. 5. The Root-Borer under the soil level. 6. The Green Borer in a shoot going down to the soil level.

Plate XXII.

Bushy Tops of Cane, containing White Borers ; these were cut in February and should have been fed to cattle at once.

PLATE XXII.



A. J. I. BUNCHY TOPS OF CANES, ATTACKED BY WHITE BORER.

THE HAND MAIZE SHELLER.

By J. M. HAYMAN, D.V.S. *(Montreal, Canada)*,

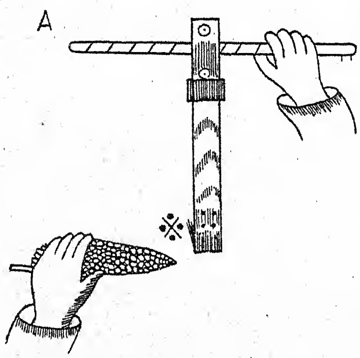
Deputy Director of Agriculture, U. P.

THIS is a small hand implement for removing the grain of maize from the cob. The principle of working is based on the motion of a screw. The idea originated from a spring which, if made to travel up a cob, will remove the grain by its free end. But the spring, owing to its want of expansion, cannot accommodate itself to the varying thickness of the cob throughout. Hence it became necessary to cut it in two and attach, in the form of a handle, a spring which would allow it to expand, at the same time retaining and improving its screw form. By gradual changes and improvements it assumed the shape shown on Plate XXIII, consisting of a wooden cross handle turning in the head of the implement two wood V-shaped springs, continuous with the head, and having at the other end the sheller in iron or brass. Externally appearing in the shape of two opposed hands, while the internal side of the opposing and somewhat bent fingers form a female screw set to a suitable pitch, so that when the point of the cob is applied to the sheller and the implement rotated by means of the cross handle, the screw grips the cob, and the sheller travels along it by reason of its screw arrangement, while the thumb of the hand removes the grain. The V-shaped wooden springs allow the hands to expand and accommodate the working of the sheller to the varying thickness of the cob. A ring at the base of the springs can be slipped forward in the case of extremely thin cobs, or if the springs should become weak with continual use, thus making it efficient again at once.

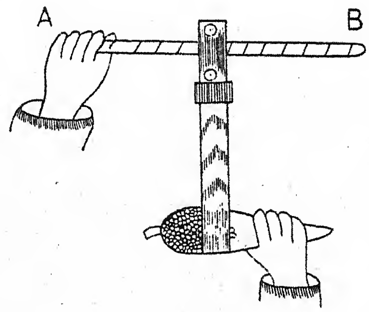
The method of working is as follows :—

Grasp the cob at the thick end with the left-hand, then take hold of the handle (B) of sheller with the right-hand. Apply the thin end of cob to *. Then turn the sheller round and round. The thumb and fingers of the sheller will be found to remove the grain and at the same time the sheller travels along the cob. When the sheller has reached about the middle of the cob, change hands, grasping the handle (A) of the sheller with the left-hand and the thin end of cob with the right. Then continue the revolving motion.

FIRST MOTION.

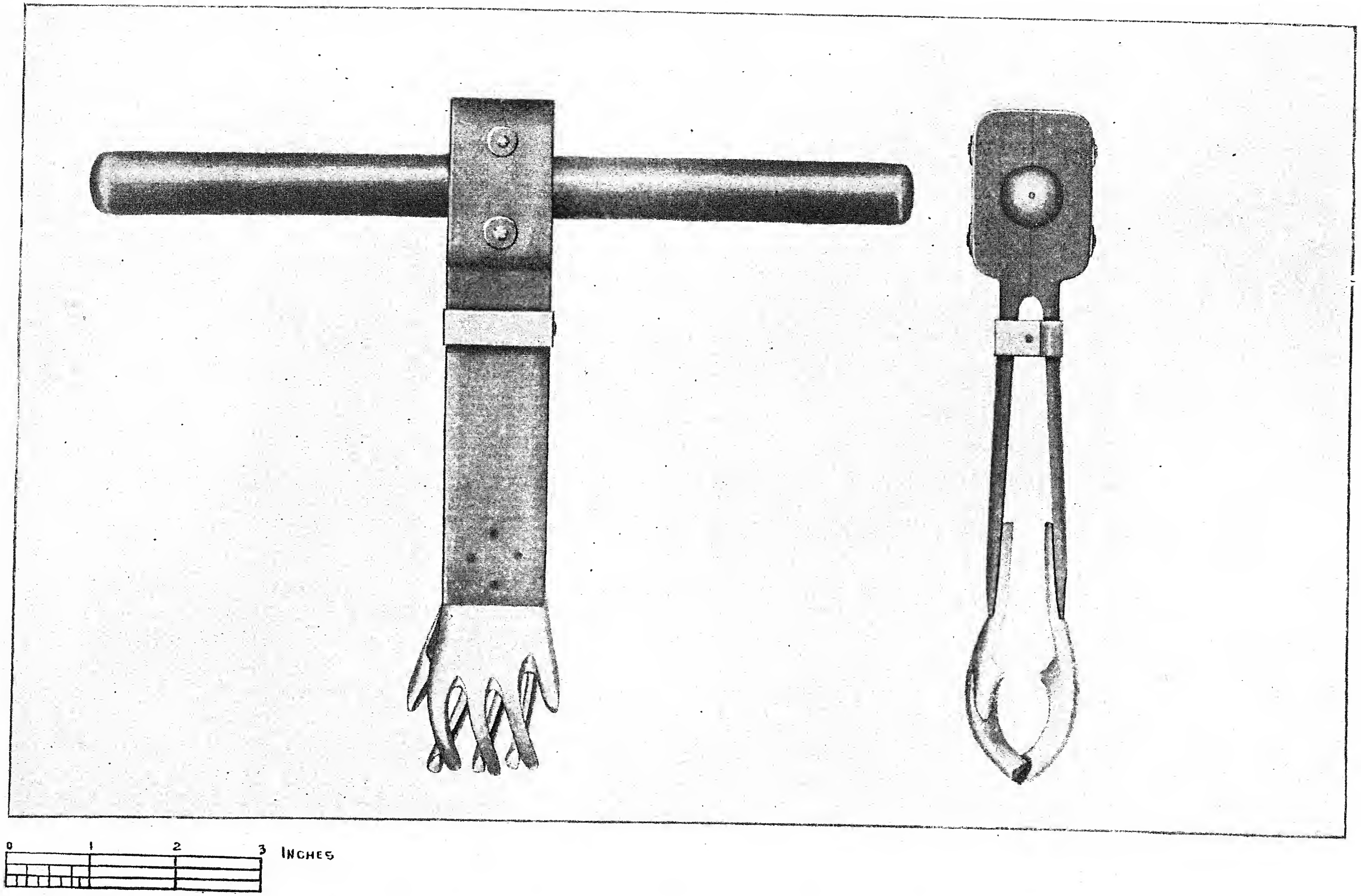


SECOND MOTION.



The sheller varies in price from twelve annas to one rupee four annas according to make. At the latter price the metal parts are brass and the whole implement generally all round made with a smarter finish. The implement is simple, has nothing to get out of order and can be worked by any boy or woman without fatigue. About 2 maunds of grain can be shelled in a day.

PLATE XXIII



A. J. I.

THE HAND MAIZE SHELLER.

AGRICULTURAL SAYINGS IN BENGAL.

By JAMINI MOHAN GHOSH, B.A.,

Mymensingh.

Every country has its sayings, and it is in the fitness of things that as one of the foremost agricultural provinces in India, Bengal should possess a wealth of agricultural folk-lore.

Like other folk-lores of Bengal, these agricultural sayings are attributed to Khana, a mythical lady, who is said to have been gifted with supernatural astrological knowledge. The reason of enshrouding them with legendary mystery, so common in this country, may be to lend a religious sanction to them, so that they may be scrupulously observed by the intensely religious peasantry of this country. These sayings are mostly in the form of couplets, dealing with the various aspects of cultivation, and are represented as being addressed by Khana to her father-in-law, Baraha. Nevertheless they very often betray in their language and observations, the rhymer to be no other than a tiller of the soil. For who but a cultivator would characterise the "uncertain heaven" with patches of clouds, as a field "broken up with axe and spade," or would consider it "a favour of Luxmi (goddess of Fortune) to have the compound of his house filled with water-gourd and cucumber" and feel "her presence when his thatched roof is covered with leaves of water-melon."

That the true cultivator must needs labour on his own soil is expressed in the saying that "he who himself works or employs labourers gains heaps and he who takes umbrella on his shoulder (*i.e.*, supervises the labourers in his fields) gains half, while the cry for want of rice rends the house of him who asks questions

(of his labourers) remaining idle in his house." Neither should one have partners in his field, for "only father and son should plough one's field, failing which take only one's own brother." Again, says another proverb, "he who having oxen does not plough suffers misery for ever."

Rain is an important factor in the agriculture of India. And it is, therefore, only proper that in Bengal, where there is practically no irrigation, a large portion of agricultural sayings should relate to rainfall.

Rain from about the middle of November to the middle of January is very injurious to the ripening paddy crop, and hinders the gathering, drying and threshing of the crop, so run the couplets,—"If rain falls in the month of *Agrahayan* (middle November to middle December) the king himself goes a-begging" (signifying famine). Also, "if it rains in *Pous* (middle December —middle January), even the husks bring money (so great is the scarcity)."

On the contrary, rain is very welcome from February to April as the ploughing and sowing season commences, and a moist soil is easy to be ploughed up, so goes the proverb:—"If there be rain during late *Mágh* (*i.e.*, early February) the holy land is of the blessed king" (meaning there is the indication of a prosperous season) and also "if it rains in *Chaitra* (middle March —middle April) there will be growth of paddy."

Again, small millets are helped by a shower in late February or early March, and we have "if it rains in *Falgun* (middle February—middle March) *Chena* and *Káon* (small millets) grow twice."

Drought in late May and early June assists the young seedlings of paddy to grow instead of being swamped by rain, but during next two months, *i.e.*, the rainy season, we must have rain for them, as also for sowing late paddy in the high lands; this is expressed in the familiar sayings:—"(If there be) any drought in *Jaistha* (middle May—middle June) and shower in *Ashár* (middle June—middle July) the earth cannot bear the burden of crops."

During the rainy season, an easterly wind would sometimes disperse a gathering cloud and without rain there is very little prospect of a good harvest, so "if there be easterly wind in *Ashár* and *Srában* (the rainy season)," the cultivator is advised to "hang up his plough and go to commerce."

Rain is very much appreciated by the peasants in *Kartic* (middle October—middle November) and is known in these parts as *Kátián*. It helps the ears to come out, and is very necessary for the development of the corn, and "Khana says that a little rain in *Kártic* (gives) twice paddy."

Now, having completed the cycle of sayings on the effect of rainfall throughout the various months of the year, we shall give some of the sayings on the signs of rain. How far they are predictive I have not been able to test, and I give them for what they are worth. But in some of them at least, there is some truth as in the fact that "when the frog croaks incessantly, know it will rain soon," but with this is coupled the rather incredible saying in which "Khana says that if it blows north-east on the first day of the year, there will be (ample) rain."

The ninth day of the new moon in *Ashár* (*i.e.*, late June) is regarded as a very significant day by the cultivators, and rain or drought on this day is believed to give the forecast for the year. Says Khana, "Father-in-law, what's the need of calculating, for if on the ninth day of the new moon in *Ashár*, it rains heavily, herons will walk over mid-ocean (meaning there will be drought), if on the other hand there be a few drops of rain, fishes will abound even in the mountain (*i.e.*, there will be heavy rain throughout the year), also if it drizzles the earth will shake under the burden of crops, but if the sun (after the day's labour) takes his throne smiling (*i.e.*, if there be a cloudless afternoon) the cattle of cultivators will be sold in fairs" (meaning a very bad year for them). The rainbow is also supposed to give indications for the year and we have "if there be rainbow on the west (sky) there will be drought throughout the year, while if there be a rainbow on the east there will be storm and rain."

A writer in an Indian agricultural paper vouches for the accuracy of the saying that "if the days be cloudy and the nights starry, these are the signs of drought, also that "the easterly wind in *Bhadra* and *Aswin* (mid August—mid October) brings a downpour," so the cultivator is advised to "go home after cutting through the *ail*" (to prevent the field from being flooded and the standing crop being injured). The halo round the sun or the moon is also supposed to be an indication of rain, and we have that "if the halo be distant, rain is imminent, while if the halo be nearer, it means flood."

I now conclude these sayings on the signs of rain, with the one which foretells "drought or excessive rain in a month having five Sundays." There are others on the subject which seem to be even more vague and arbitrary than even some of the preceding ones.

Paddy being the staple crop, receives the greatest attention in these sayings, and so we have the favourable circumstances for a good harvest summed up in a single couplet thus,—"If (the fields) are full (of water) in Cancer* and dry up in Leo, also if they are filled to their ears in Virgo, and if it rains without wind in Libra, then where will ye keep your paddy?" (so abundant will be the harvest.)

The lowlands, specially in Eastern Bengal, are inundated by the overflowing of rivers during the rainy season. The yearly inundation is also a very vital factor to agriculture as it leaves behind a deposit of silt. A high and sudden rise of water will destroy the standing crops, while a low and slow rise is beneficial for the development of the plants. And so "the first rise of water in *Baisakh* makes the *aus* paddy grow twice." The indications of inundation seem rather queer, thus "if it is warm in *Pous*, cold in *Baisakh*, the pits will be filled in by the first part of *Ashár*, and Khana says, O my husband, there will be no water in *Srában* and *Bhadra*." Also, "if during mid *Ashár* southerly wind blows, there will be flood during the year." But

* In the Hindu Astrology, months often go by the name of the signs of the Zodiac.

the queerest of all is that which would foretell a good harvest of paddy from a good harvest of mango, and also a flood from a good season of tamarind.

Conditions of soil and of climate differ very much with different places, yet the above may be taken to represent fairly the circumstances for a good harvest in a normal year. But it would be absurd to lay down for the whole of Lower Bengal and for high and low lands as well that a cultivator would be "happy and prosper in husbandry and also gain honour if he plants paddy within five days of the month of *Ashár.*" Neither can it be advised with certainty to "plant as much pulses as one can from the fourth of *Bhadra* to the fourth of *Aswin.*" Also there is much truth when "Khana would advise a son of the peasant to sow mustard seeds during the latter part of *sarat* (*i. e.*, mid September to mid October). Also "he who without transplanting chilli seedlings in *Bhadra* or *Aswin* spends his time in sleep and in the *Kártik* and *Agraháyan* (*i. e.*, the next two months) transplants the old seedlings, will not have to fill his store of chillies, as those plants will die of fungus diseases."

Again, among the sayings on the proper time of planting is one which advises a husbandman to "plant turmeric in *Baisakh* or *Jaistha*, throwing away pieces and dice, to hoe the soil in *Ashár* and *Srában* and to make it thorough in *Bhadra*, (otherwise) says Earth, 'what yield can I give, if planted on any other rule.'" Also, "if you don't plant *Ol* (*Amorphophallus companulatus*) in *Falgun*, then there will be topsy-turvy in the end," so also *Patal* (*Trichosanthes disica* Roxb.) planted in *Falgun* gives twice the crops."

The sayings on the planting of bamboo are rather interesting. Thus we have "O brother cultivator! plant bamboos eight cubits apart at a depth of one cubit, and after planting three hundred and sixty clumps of them, lie ye peasant, on your bedstead." Presumably one or two bamboos from each clump, would enable him to provide for his daily necessaries throughout the year. But the reckless cutting of bamboos would destroy a clump, so a man wishing to preserve his bamboos must be "as

stiff (sparing) as the twig of a bamboo," for "the cocoanuts of the spendthrift, and the bamboos of the miser do not run short throughout the year." Wholesale destruction is also reprehensible in the case of plantain, which is also a very important plant, as its flower, leaves and even the trunk are of everyday necessity in a household. The leaves serve the purpose of plates and are largely utilised during feasts even in the houses of the rich, while the flower and the trunk are cooked up for meals. Nevertheless the "leaves must not be cut off as soon as planted," for that would injure the plant, and it is the peasant's interest to save a valuable plant "that would provide him with cloth and food".

Ploughing is begun on auspicious days, and the Hindu cultivator consults the village astrologer before beginning to plough his fields a-new. Many stringent rules have been laid down for it. Thus, "Hear cultivators, says Khana, when you go to your fields with plough, seek out an auspicious moment for that, also let not have any untoward news on your way, next ascertain the directions and begin ploughing from the east, then will your whole labours be fulfilled without fail." The cultivator, also, should not "take to his plough on the new and the full moon, for then his misery would last for ever, his bullocks will have gout and he will not have food in his house."

That different crops would require different degrees of preparation of the soil is laconically summarised in a single couplet. Thus the radish requires a thoroughly prepared soil, so "sixteen ploughings" are laid down for it, and "half of that for cotton," a tap-rooted plant. But paddy having crown-roots, "half of that" (*i. e.*, four ploughings) would suffice for it, while "the betel-vine (would grow) without any ploughing." Also "the soil for sugarcane should be thoroughly pulverised," which requires a great deal of labour, so "let him who has grandsons, great-grandsons cultivate sugarcane." Again, the soil for *Man* (*Arum indicum*) is prepared by a spade, while ploughing is required for preparing a soil for *til* (*Sesamum indicum*).

That some plants would thrive in light, while others would require shade, has not also been lost sight of in these sayings. Khana would say "Paddy in sunshine, and betel-vine in shade, (thrive);" while "though the *Ol* in shade would itch the mouth, it would do no other harm." But it is to be doubted whether "the potato would circle round the plant (*i.e.*, abound) if planted near a bamboo clump."

Next we come to the sayings on the soil. Different crops require different soils, so we have "sandy loam for *aus* paddy, and clayey loam for jute." Again says Khana, "Hear me, O son of a peasant, plant *Patal* on the sandy soil, for that will bring you to your desire's end." Also "if you plant *Kachu* on the river bank, it will go three cubits deep under ground."

The rich soil of Lower Bengal, fertilised for the most part by an annual deposit of silt, requires very little of artificial manuring for the staple crops; besides in India, manuring has not been systematised and its utility is not so very well understood as in Europe and America, so there are practically no sayings on the manures for field-crops. Nevertheless, there is some very practical and sound advice in these sayings; thus "if one scatters ashes in a *Kachu* field, Khana says, there will be no end of them" (*i.e.*, it will give plenty of yield). In the case of bamboo it is advised "to loosen the soil in *Falgun*, to put (fresh) earth (at the root) in *Chaitra*, for 'with such treatment,' says bamboo, 'I grow soon.'" Also "Hear, ye! son of a cultivator! put the husks of paddy under a clump of bamboo, for if husks be put at the foot of a bamboo two *Kurs* of land will be covered by the clump. Water in which fishes have been washed is said to be good for water-melon, while "chillies thrive in paddy-lands."

While concluding our observations on these 'rudely-caroll'd chiming phrase, in uncouth rhymes' we cannot but admire them for the broad commonsense, and the keen observative nature they sometimes display. These also give an insight into the character of our peasants. Though prejudiced and imbued with a firm belief in fatality which is ingrained in an oriental nature, they have sense enough not to be solely guided by these

sayings, however oracular they may be represented. No cultivator would hopelessly give up his plough though in the coming Bengalee year "Saturn is the king and Mars his minister, and in vain would one hoe and plough," rather should he join in the pious prayer of our fathers in the holy Rig Veda, "Sweet be our crops, sweet be our cattle."

WORK DONE TOWARDS THE IMPROVEMENT OF COTTON IN THE BOMBAY PRESIDENCY.

By G. A. GAMMIE, F.L.S.,

Imperial Cotton Specialist.

In 1788, the constantly increasing demand for cotton, which arose in Europe after the invention of the steam engine and the labour saving machinery of the mills, induced a representation by British manufacturers to the Honourable East India Company on the subject of encouraging and improving its cultivation. They particularly specified the variety from which the superior Dacca muslins were made, the supply of which was diminishing.

In the Bombay Presidency cotton of the best quality was produced in Broach and Ahmedabad. That of Surat was held to be inferior and that of Kathiawar was said to be worst of all.

In 1802, it was stated that the district of Broach and other territories in Guzerat, ceded to the Company in 1776, paid a portion of their revenue in cotton. In addition to the cotton received thus, the Company purchased a quantity for shipment to China.

In 1810 two commercial firms represented that the purchases of the Company had raised cotton to a ruinous price, and they asked Government to withdraw its competition for a time. This it declined to do, asserting at the same time that they did not monopolise the market.

A quantity of West Indian and American cotton seed was forwarded by the Court of Directors with printed instructions

for their cultivation, which, when translated into Guzerati, were not considered of use to the ryots. In 1809, in consequence of the suspension of intercourse with the United States of America, a great increase occurred in the export of Indian cotton to England, but on the resumption of intercourse, the Court stated that a large quantity remained unsold on account of the renewed understanding with America and the coarse nature of Indian cotton. In 1812-13 they ordered that no cotton should be shipped to England on their account. They urged the necessity of securing greater cleanliness in the cotton. The mixture of seeds and dirt was the chief objection to its use, and they repeatedly gave positive orders that the defects complained of should be remedied.

In 1810 the Court directed the attention of the Bombay Government to the Island of Salsette as a suitable locality for the cultivation of American cotton. On a report being called for, it was pointed out that although stray Bourbon plants had naturalised themselves on the island, every attempt to cultivate the species had failed.

In 1815, an experiment with the same species on a large scale was conducted in the Kaira district of Guzerat and resulted in failure, which was attributed to the lack of moisture, although the country cotton yielded well under the same conditions. This trial having been conducted in the western part of the district where the soil was considered chiefly at fault, during the following year the experiment was repeated in the eastern part where the plants grew luxuriantly without irrigation. The produce was reported on in London as being the best sample imported from Bombay raised from Bourbon seed. The expense of cultivation, however, was so great that there was a loss of 28 per cent. on the transaction. Small experiments in 1817-18 with the same species in the Ratnagiri district were reported to have been entirely satisfactory. To encourage the extension of Bourbon cotton in the Kaira district, the Collector was authorised to offer substantial premiums for successful cultivation, but even this inducement seems to have failed in its object. Bourbon cotton subsequently sent to London

from this district, was not received favourably in the market where it was considered to show signs of deterioration.

In 1828, the consumption of cotton had become so enormous that the importance of improving the quality of Indian cotton was pressed upon the attention of the East India Company. It was thought that some means should be devised to divert the steady flow of money for the new material from the United States to British possessions. It was assumed that the inferiority of Indian cotton was due only to defective methods of cultivation which could be remedied by the application of skill and capital. The Court of Directors asserted that the Guzerat cotton was not suitable for the British market on account of its very short staple, and this defect existed in spite of the fact that Guzerat was equal in richness and fertility to any part of the world. The attempts at improvements had been confined to the introduction of Bourbon cotton only and had not been attended with success.

Lord Ellenborough suggested "the expediency of attempting on a small scale the cultivation of all the finer sorts of foreign cotton in different and distinct parts of India, under every different circumstance of soil and climate, and of transmitting to England, cleaned in the American manner, samples of the cotton so raised, for comparison with the cottons of other countries."

The Court of Directors wrote urgently on the subject to the Bombay Government in February 1829, directing it to select about 200 acres to serve the purpose of an experimental plantation at the cost of the State. They suggested, as a commencement, the careful cultivation of the finest indigenous kinds in India, such as the *Bairati* of Bengal (the Dacca Muslin Cotton) and the best descriptions grown at Broach and Surat. At the same time a supply of Georgian and New Orleans seed was ordered. They also proposed that experiments should be made with the finer sorts of exotic cottons in various parts of the Presidency and especially in the districts near the coast. They further recommended the distribution of good seeds to the rayats, and the award of premiums to those who exhibited superior samples, and they also sanctioned the lease of lands at a low

rental to all British subjects disposed to embark on cotton cultivation. Subsequently a supply of Upland Georgian, New Orleans, Sea Island and Demerara cotton seeds was sent to Bombay, with printed instructions as to their cultivation. Two of Whitney's saw gins were sent with the sanguine hope that they might expand the cotton trade prospects of India as they had already done those of America.

The Bombay Government established experimental farms at Broach, in Guzerat and in Dharwar and Khandesh. A few plantations were also ordered to be made in Salsette. The Superintendent at Broach commenced operations by purchasing small quantities of seed cotton which he had cleaned under his own supervision. The cost of cleaning by the foot roller was prohibitive, but the cotton was considered excellent by the London dealers, as was also the cotton cleaned by the *Churka* or hand gin, but that prepared by the American saw gins was injured so greatly that the staple was cut to pieces.

In the Southern Mahratta Country, the Superintendent decided to adopt the following line of action :—to clean the cotton in an economical way so as to increase its value without adding too much to the cost of production and to distribute seeds of the best Guzerat, New Orleans and other annual cottons, so as to produce new varieties of the staple. The cleaned cotton which he produced during the first year on a small scale by more careful methods of picking and ginning, was favourably reported on, but he failed to persuade the rayats in general to adopt his systems. He represented that the bad state of Dharwar cotton was really due to grave faults in the mode of packing and carriage, this being to carry it in loose bags on the backs of bullocks which were daily loaded and unloaded on their way to the coast. The farm established at Sigehali was not prosperous, and the yields from exotic cottons were small and unfavourably reported upon.

As the results of 18 months' experience on his farm at Danda in Broach, the Superintendent averred that no improvement could be expected from any alterations in the mode of cultivating cotton in Guzerat. Finally, the experiments with exotic cottons

were abandoned on the ground that there was no probability of their returning a reasonable profit to the cultivator.

The Superintendent at Dharwar in 1835 arrived at the conclusion that the cultivation of perennial cottons would not extend throughout the district. The Collector, being referred to for his opinion, said that after five years of experiments no rayat even in the vicinity of the farms had taken up any foreign cottons, and, moreover, that no one had altered his methods of cultivation or other processes in any way whatever. It was also reported that all cottons of long staple had become short, and that the American saw gins had failed by cutting and twisting the staple, while the indigenous foot roller was not adapted to foreign cottons. In 1836 it was decided to abolish the experimental farm in Guzerat and the Southern Mahratta Country, as to continue them longer was held to be a useless expenditure of the public money. In the same year, it was proved that the soil and climate of the Deccan were not congenial to cotton.

In 1840, Dr. Gibson stated his conviction that, of the exotic cottons, only the New Orleans succeeded under trial in the Deccan, and he also urged the futility of further experiments with Pernambuco and Egyptian cottons in inland situations.

Private speculators who availed themselves of the facilities granted to cotton cultivators met with no success in their enterprise, and Sir J. R. Carnac, then Governor of Bombay, asserted that "cotton culture holds out no inducement for any private person who knows what he is about, to engage his capital in any speculation on a large scale."

For some years subsequently only a few measures were taken towards the improvement of Indian cotton. Cotton seed was distributed and advances were made to certain persons and several unsuccessful attempts were made to improve the *Churka*. An Egyptian machine was proved to be no better than this. A grant of £100 was made by the Court of Directors as a premium to any mechanic who could produce a serviceable model, but even then no promising result was obtained. The Government in 1836 repealed the tax of Rs. 2-12 on each

Churka, whether worked for one day only or throughout the season. This tax produced Rs. 14,000 annually. In the following year, 1,500 additional machines were being worked in the town of Broach alone. In 1839, the local authorities were directed to take steps to abolish the *kuli* system in Guzerat. It had hitherto been the regulation that the cotton crop was stacked in the *kuli* or village farm yard until the assessment was paid.

In 1838, the growing necessities of the British manufacturers again compelled them to submit their periodical petition for a supply of improved Indian cotton. The Court of Directors, which had always responded willingly but unsuccessfully to this cry, resolved to secure the services of experienced American planters for the purpose of training cultivators in the best methods of growing and cleaning cotton.

Three American planters proceeded to Broach in 1840, and, as usual, arrived too late to start the actual cultivation of cotton that season.

In the following season, they sowed New Orleans seed in three farms, but the plants thrived so badly that the total produce did not amount to a bale of cotton. A plot of Sea Island was also entirely destroyed by insects. An experiment was also made with a quantity of indigenous cotton cultivated in the American manner, but the cotton ultimately produced was not in any way superior, either in quantity or quality, to that grown by rayats.

The American planters were convinced that the New Orleans could not be profitably introduced into Guzerat, but they believed that the quality of the indigenous cotton could be improved.

The three Americans so despaired of success that they resigned their appointments and left the country.

In 1842-43, only five small plots were prepared and sown with New Orleans, Sea Island and Bourbon seed, but the product collected from these only amounted to about 11 pounds per acre.

The exotic cottons of the year 1843-44 failed, and it was now accepted as proved that the soil of Broach was unsuitable for the cultivation of American cottons.

In 1843-44, nothing was done beyond again demonstrating that the saw gin injured the staple of Indian cottons.

In 1849, after a few years of misdirected efforts, the Government of Bombay decided to abandon further experiments at Broach.

The results of the whole series of experiments at Broach have been summed up as these :—"Some kinds of exotic cottons, such as the New Orleans and Bourbon, yielded occasionally a small crop, when cultivated as garden plants, with great care and great expense, but they never escaped partial damage from the effects of the season. When the same kinds were cultivated on a larger scale, even with the greater skill, labour and care of the experimental establishments, the crop invariably failed. The possibility of raising garden samples of any kind of cotton, anywhere, by unlimited care and expenditure, is scarcely doubted, but the feasibility of doing so upon terms within the reach of the rayats and within the actual market value of the article, has not been demonstrated at Broach. It was proved that, by double the care and attention and more than double the expense of the native cultivation, a large yield and better and cleaner quality might be obtained from the indigenous cotton than the rayats can produce, but not sufficiently so to repay the additional outlay, and, finally, that the native cotton, when cleaned by the American saw gin, was generally injured in its staple."

In the Surat, Kaira and Ahmedabad districts experiments with Upland Georgian, Bourbon and other exotic cottons were conducted between the years 1849—1860, but in every case these failed and the same unhappy results were experienced in some of the Deccan districts and Thana in the Konkan.

In 1844, it was proposed to test the cultivation of improved varieties of cotton in the Khandesh district. New Orleans was tried, and, as usual, having failed, Government ordered that no further attempts should be made in its introduction to this district. In spite of this discouragement in 1848-49, New Orleans was again sown, but owing to an adverse season the crop was extremely short, and it was considered by the merchants as being

superior to the indigenous cotton although inferior to New Orleans. The yield of exotic cotton was calculated to be about one-third that of the indigenous variety. In 1855, the cultivation of New Orleans cotton had practically died out and the rayats emphatically expressed their conviction that the climate and soil were absolutely unsuitable for its culture.

In Ratnagiri in the Konkan, experiments with Bourbon and Sea Island cottons at first were promising, but further trials on a large scale resulted in loss.

In the Belgaum and Dharwar districts, experiments for the introduction of New Orleans cotton were commenced in 1842, and after some reverses the cultivation of the plant became fairly established, and it has maintained its hold in certain favourably situated Talukas up to the present day.

The net result from the expenditure of money, skill and experience during nearly 80 years was that the New Orleans cotton was successfully introduced into the Karnatak and that it refused to grow with certainty in any other parts of the Presidency. This remains the only exotic cotton now grown as an annual field crop in India. All perennial tree varieties have been definitely proved to be unreliable as sources of profit.

Throughout the whole of the history of the attempts to improve the cottons of India it is sufficiently evident that no consideration was ever given to the chance of improving any indigenous variety by scientific methods; the sole aim seemed to be to compete with the American market by introducing the cultivation of its chief cotton varieties into India. The following remarks written by Dr. Forbes Watson afford ample food for reflection to the agriculturist.

"It has been pointed out that, as regards length of staple, the cotton of Western and Southern India compares favourably with that produced by the short stapled cottons of the United States of America. The principal objection to Indian cotton is its great impurity caused by the admixture of broken leaf and crushed seed which it contains. These objections will probably never be quite surmounted, because the presence of leaf is due

to the greater dryness of the Indian cotton plants at the time of picking and the presence of fragments of seed is caused by the firmer adhesion of the cotton to the seed. Indian grown cotton from acclimatized Bourbon and Upland Georgian plants is freer from broken leaf, showing that it retains one special characteristic of the American cotton plants in which the leaves remain in a more succulent condition throughout the time of harvest.

"Another grave objection to Indian cotton is the injury which it suffers from neglect or adulteration.

"To remedy this last and fatal defect a Cotton Fraud Act was brought into operation in Western India in 1863, but it is doubtful whether the attempt to improve matters by legislation was successful or not. However, tons of earth and sand were removed from cotton during its operation and the mixture of inferior with superior qualities was prevented to a certain extent."

SANN-HEMP, AMBARI AND AGAVE AS FIBRE CROPS IN THE CENTRAL PROVINCES AND BERAR.

By D. CLOUSTON, B.SC.,

Deputy Director of Agriculture, Central Provinces and Berar.

THE only fibre crops other than cotton grown to any extent on a field scale in these Provinces are Sann-hemp (*Crotolaria juncea*) and Ambari (*Hibiscus cannabinus*). The total area in 1907 under fibre crops other than cotton was 55,402 acres in the Central Provinces and 32,361 acres in Berar. Sann is always grown as a pure crop, but Ambari is only cultivated as a mixture with other *kharif* crops. In Berar it is estimated that 24,099 acres were actually occupied by Ambari in mixed crops, and 8,262 acres under Sann. The area occupied by Ambari in mixed crops in the Central Provinces is not separately computed, so that the return of 55,402 acres shows the area under Sann alone; no estimate can be attempted of the area under Ambari.

Sann or Jubbulpore hemp (*Crotolaria juncea*) is a leguminous crop cultivated in these Provinces for its fibre only. *Crotolaria juncea* is supposed to be the only variety grown locally, though Roxburgh calls Jubbulpore hemp *Crotolaria tenuifolia*. The correct botanical classification is a matter which has not yet been authoritatively decided and requires investigation, but it is generally believed that only one variety is grown throughout the Central Provinces and Berar. It thrives well on almost all kinds of soils that are free from water-logging. The land on which it is grown gets very little cultivation. It

is usually ploughed or bakhared once in the dry weather, followed by one bakharing after sowing the seed in the beginning of the rains. The seed is sown broadcast at the rate of about 80 lbs. per acre. The crop is a vigorous grower, requires no weeding, and is sometimes even grown on *kans*-infested land, where it is supposed to be effective in killing this obnoxious weed. The plants attain to a height of seven feet on good land, and from 4 to 5 feet on poor land. The crop is generally cut in December by which time the seed is matured. The crop is cut with sickles and bound into bundles which are usually stacked in the field till March or April. By postponing the time of retting till the hot weather, a much shorter period of immersion in water is found to be sufficient. The bundles are steeped in streams or in ponds made near wells. Dirty water is always preferred as it hastens fermentation. The bundles are placed, heads and tails, two tiers deep, and are weighted down with stones or mud. When the water of a stream is not sufficiently deep, a trench is dug into which bundles are placed and covered with the mud taken from the trench. In retting, the bark is partially removed by drawing a handful of the stalks between the thumb and first finger. The stems are then stripped one by one. The retter, having broken the lower end of the stalk so as to get a free end of the fibre, grasps this end of the stalk with his left hand and removes the fibre in strips by running up the thumb and first finger of the right hand between it and the stalk. The cost of retting is considerable. Day labourers on the Experimental Farms produce about 4 lbs. of fibre per day only. Cultivators commonly pay one pice per bundle for retting. If a suitable machine could be secured, which would extract the fibre at cheap rates, a great impetus would be given to the cultivation of Sann. In some places baling presses have been set up, so as to reduce the cost of carriage.

When the grower keeps the fibre for his own use or sells it in small lots at the bazar, he washes off the mud attached thereto. If it is to be sold in bundles for export to Bombay, some cultivators not only neglect to wash the fibre but even

take steps to increase the weight by fresh additions of sand or mud, always taking precautions to cover the outside of the bundles with the cleaner material. This method of adulteration has given rise to serious complaints in the trade. It was not noticed till the famine of 1899—1901 when, owing to the great scarcity of water, Sann had to be steeped in muddy water, which resulted in the export that year of very dirty fibre. As the buyers had not suspected this, the fibre was sold at good prices, and the cultivator, assuming that this form of adulteration could be repeated with impunity, adhered to the practice. In 1907 Messrs. Kiddle, Reeve & Co. complained that some of the fibre that came from certain districts of the Central Provinces contained as much as 80 per cent. mud, while that received from Konkan, Guzerat and the Deccan contained less than 2 per cent. They were fully convinced that the mud was wilfully added. The steps taken by the Local Government to stop this malpractice were so effective that in 1902 the same firm reported that "the extraordinary admixture of dirt which appeared in the hemp offered for sale during the past two years, and more especially during the last cold weather, has almost entirely disappeared from the supplies which are now arriving in considerable quantities." But in 1903 adulteration of the fibre was again practised, and the same firm again drew the attention of the Local Government to it in the following terms: "During the past season, 1903-04, the mixing of earth with the fibre has been carried on in a very gross manner and to an extent even greater and more general than during the worst period prior to our invoking your assistance." The Local Government once more used its influence through its District officers in checking this wholesale method of commercial swindling, and its measures were again successful. In districts from which the dirtiest fibre had been received, the names of local buyers (middlemen) were taken and forwarded to the firm for the guidance of their agents.

The area under Sann in these Provinces has been doubled during the last 10 years. The principal districts in

which it is grown as a fibre crop are in the Central Provinces—Betul 11,323 acres, Seoni 8,645 acres, Mandla 5,844 acres, Narsinghpur 4,851 acres, Jubbulpore 3,867 acres, Raipur 2,390 acres and Nagpur 2,010; in Berar—Yeotmal 3,106 acres, Buldana 2,069 and Akola 2,025. The probable reason why the crop is largely grown in these districts is that aboriginal cultivators are numerous and not that climatic conditions are peculiarly favourable. The Spanish-American war gave a considerable impetus to the trade, as the price of Manilla hemp rose from £14-10-0 per ton in 1897 to £62-10-0 in 1899, and the much improved Sann-hemp was found to be a good substitute. Prices have been well maintained ever since; at present it ranges from Rs. 8 to 9 a maund, at which price Sann, if grown on land suited to the crop, will pay better than some other crops commonly grown at present. Moreover, its cultivation is well understood and the crop is a hardy one, so that its cultivation is likely to extend. It is fully recognized that land is substantially benefited by a crop of Sann, which is considered equivalent to a good dressing of manure. To a limited extent Sann is also grown to plough in as a green manure, particularly for irrigated wheat in Nimar and sugarcane in Betul.

A careful estimate of the comparative costs of cultivation and outturns of wheat and Sann, shows that the latter is the more profitable crop. Land is not ordinarily manured in the wheat tract. The cultivator either uses his cattle dung as fuel for his own purposes, or sells it in the nearest town where there is always a good demand for cow-dung cakes. The wheat on such land, impoverished as it is in nitrogen, is invariably of stunted growth, attaining a height of about 1½ feet only. Sann being able to get supplies of nitrogen from the air grows much more luxuriantly so long as the land is well drained. On the well-drained deep alluvial soil along the banks of some rivers, commonly known as *Kacchar*, which is excellent land for wheat, Sann cultivation is so much the more profitable that it has been largely substituted for wheat. In some cases the tenant who may not be a proficient Sann-grower himself or is perhaps

influenced by prejudice, lets such land to *Gonds* and other low caste cultivators who are expert in cultivating Sann as well as in preparing the fibre for market. These sub-tenants are said to pay as high as Rs. 50 an acre for good *Kacchar*, and the crop of Sann grown thereon is said to fetch as high as Rs. 100 per acre. It is believed, therefore, that Sann can be grown more profitably than wheat in the wheat-growing tracts, even after making due allowance for the costly process of hand-retting practised at present. Its cultivation has extended and will continue to extend in that tract if prices remain as high as they have been of late. In the cotton tract no extension of this crop can be looked for, as cotton pays better even than Sann. In the rice tract Sann could be profitably grown on much of the land that is at present reserved for cold-weather crops.

Anything like a rapid extension of Sann cultivation will, however, be impossible for the following reasons. Many high caste cultivators are prohibited by religious prejudices from growing the crop. They will grow Ambari for their own use, but Sann never. The cultivator who grew it in defiance of caste rules was outcasted. Its cultivation has, however, proved so profitable of late that some high caste cultivators have waived their religious prejudices, and now grow the crop. The good *Kunbi* compromises the difficulty by employing a Gond or other low caste man to sow his Sann seed for hemp. Again, the labour necessary for retting the stalks is expensive, and considerable difficulty is often experienced in getting sufficient water in the dry season for steeping the bundles of stalks. The cultivator in the rice tract is not willing to grow a *kharif* crop such as Sann on his *rabi* land, as he already complains of the shortage of labour to transplant his paddy owing to the great amount of work demanded of him within a short period of time at the beginning of the rains. What he wants is to distribute his work more equally over the whole year, whilst the extension of Sann cultivation would have the very opposite effect. The most formidable difficulty of all in the way of extending the cultivation of this or any other

fibre crop is not to prove that it is a more profitable crop than other crops, but rather to overcome his prejudice against growing any crop which is neither a food for himself nor his bullocks, more especially if its preparation for market entails a good deal of labour. At present then the cultivation of Sann-hemp in these Provinces is still to a large extent monopolised by low caste cultivators, who find it more profitable on the land suited to it than any other unirrigated crop grown. Some of these cultivators are sub-tenants who pay extravagant prices for good Sann-growing land in virtue of the profit they derive from its cultivation. Despite the prejudice against the crop, its cultivation is almost sure to continue to extend if prices continue as high as they have been for the last year or two. Being a leguminous crop, its power of enriching the soil in nitrogen should recommend it as a good crop to grow in rotation with cereals.

The area under Sann-hemp in the Central Provinces has increased from 29,094 acres in 1896 to 55,402 acres in 1907. The total quantity of Sann-hemp exported and the value of the same from 1904 to 1906 are shown below :—

	Weight. Mds.	Value. Rs.
1904	226,751	12,18,783
1905	201,402	10,82,534
1906	176,730	9,49,923

Ambari or Deccan hemp (*Hibiscus cannabinus*) is also grown to a small extent in these Provinces. Its fibre is inferior to that of Sann, the bazar price per maund being about Rs. 6. I am not aware that their outturns have been experimentally compared, but the general opinion is that Sann gives the greater outturn of fibre also. In the Central Provinces, Ambari is grown only as a mixed crop with juar, tur, mung, urad and cotton, the common practice being to mix half a pound of Ambari seed with that of the principal crop. This method of sowing Ambari tends to give rise to branching in the plants, but as the fibre is only required for the cultivator's own use, this is not so important. There does not seem to be a great future for this fibre crop in

these Provinces. At present it is grown on a small scale in preference to Sann because of the prejudice of the growers against the latter crop.

Agave is another fibre crop which has been but little exploited in these Provinces. The species common to the Central Provinces is believed to be *Agave cantala* species. It is usually grown in hedges around groves and gardens, but nowhere in abundance. It is very seldom utilized for the extraction of fibre. In the Kawardha Feudatory State adjoining Bilaspur, it is cultivated on a somewhat larger scale and its fibre is used not only in manufacturing ropes, but also in making valuable cloth; and the root is used in the processes employed in the manufacture of gold and silver ornaments. The cultivation of Agave is never likely to become popular in these Provinces. As in the case of *Sann*, the better class of cultivators are prejudiced against it. The labour involved in pounding the leaves in the process of extracting the fibre is considered both hard and degrading, while the juice of the leaves produces *eczema* or *dermatitis* on the legs and arms of those engaged in extracting the fibre. The prejudice is perhaps due to the fact that the extraction of aloe fibre is a regular jail industry and not a common village practice. A crop which gives no outturn for the first three years does not appeal to the average cultivator whose tendency is to look for speedy returns on his invested capital. Again, cattle destroy the crop in its young stage, if the cultivator cannot afford the necessary protection for the first year or so. And finally, on soils of average fertility it is believed that the crops grown at present are more profitable. Aloe cultivation has been largely extended of late at the jails of these Provinces. The species grown are chiefly *Agave cantala* and *Agave rigida var. sisalana.* Major W. B. Lane, I.M.S., Inspector-General of Prisons, Central Provinces, had 87,459 aloes planted out last year in the various jail gardens, of which 17,575 were planted in the very thin laterite soil known as *bhata*, round the Raipur Jail. At these jails all the work of cultivation, of extracting the fibre and of making it into ropes, rugs, etc., is done by the prisoners. This industry is a most suitable one for

jails, as it affords labour at all times of the year and of different degrees of hardship, from light to very heavy tasks, and is, therefore, suitable for all kinds of prisoners. The only retting machine that has given satisfactory results is Winsor's. One of these is already in use, and two others have been ordered for districts where the jail population is small. There seems little possibility of the cultivators taking up the cultivation of Agave as a fibre crop for reasons already explained. On the *bhata* plains of Chhattisgarh, however, where there are hundreds of thousands of acres of waste land lying unused at present, it may be possible to start aloe plantations; but if this is to be done successfully, the work will have to be undertaken by an enterprising firm with sufficient capital and practical knowledge to manage it properly. It has yet to be proved, however, that the aloe can be profitably grown for commercial purposes on these murram soils without irrigation. The plantations started at the Raipur Jail should solve this problem.

KATRA (HAIRY CATERPILLARS) IN GUJARAT.

By CHHOTABHAI U. PATEL,

Entomological Assistant, Baroda State.

KATRA is a Gujarati name given to the hairy caterpillars of the following three species :—

1. *Amsacta moorei*, Butl. 2. *Amsacta lactinea*, Cram. 3. *Amsacta lineola*, Cram. The general characteristics of these insects in Behar have been described in the third issue of the Agricultural Journal of India, Vol. I, page 187, where the moths were figured in colour. The three species differ a little from one another in points of minor importance, and so they have not been described separately here.

In almost all parts of Gujarat and Kathiawar, these insects are to be found, and are known by different names in different parts; *viz.*, "Katra" (in Baroda and Kadi districts), "Bava" or "Kutra" (in Kathiawar). Generally, these insects appear after the first fall of monsoon rain and attack the newly growing crops. When the circumstances throughout the year are favourable to their increase, they appear in swarms and cause very great damage to the young crops, especially to millets, so much so that whole fields have to be resown. Thus by late sowing the plants do not become vigorous and as a consequence the yield is poor. At times it so happens that in sowing and resowing, the season for a particular crop passes away and people have to put their fields under some other crop for which no previous preparation was made; or they have to leave them fallow.

Thus it is that, while the immediate loss causes a waste of seed and labour, the ultimate effects of its ravages are very great.

This is why the word "Katra" has become proverbial among the Gujarat cultivators. An accurate survey of its distribution in Gujarat has not yet been made, but there are certain villages in the Atarsumba Peta Mahal (near the Kapadvanj Taluka of the Kaira District), where they appear in swarms every year regularly. At other places in Gujarat, they appear in a small number every year and in swarms every third or fourth year.

Life History of the Insect.

Before devising measures of treatment, one should know the full life history of the insect. In the following paragraphs, it has been described from field observations, and failing these, the insectary observations have been noted at some places.

Eggs.—These are small round bodies of the size of poppy seed with grooves parallel to the shorter axis, evenly distributed on the surface. There are a few thin, white, short hairs scattered over the surface. They are yellowish when freshly laid and become dark before hatching. They are laid by the mother generally on weeds grown on headlands and in some cases in the fields. Each female moth lays from 700 to 1,000 eggs in four or five rows touching one another. The egg stage lasts from 2 to 3 days.

Larva.—After two or three days very small Larvæ (caterpillars) begin to appear. The tiny caterpillar eats its way out of the egg-shell in about a couple of hours. The newly hatched larva is about $\frac{1}{10}$th of an inch in length. The colour of the body is dark and there are long, thin hairs scattered over the upper surface of the body. The mouth parts are orange red. It is, as usual, provided with three pairs of legs and five pairs of sucker feet. Its sole business is now that of feeding and growing. For some days the caterpillars feed on weeds near by, and by the time the cultivated crops begin to grow, they (caterpillars) grow big enough to walk into the fields. Their favourite food plants are "Chidho" among weeds; Bajri (*Pennisetum typhoideum*),

jowar (*Andropogon sorghum*), Kodra (*Paspalum scrobiculatum*) and the first two leaves of Tuer (*Cajanus indicus*) among cultivated crops; and the leaves of Thoria (*Euphorbia neriifolia*) among living hedges. They grow fast and attain a length of an inch or $1\frac{1}{4}$ inch in ten to twelve days.

The colour of the body is now changed to orange and there are small white nodules at the base of each bunch of 10 or 12 long orange coloured hairs. If there is not sufficient food for them, most of them die before attaining this stage. If the leaves on which they rest, are shaken or slightly disturbed, they at once fall to the ground and run actively to hide themselves. In another 10 to 15 days, they become full fed. They are now about $2\frac{1}{2}$ inches in length. The greater number of them go into the hedges for pupating.

Pupa.—Though no living pupa has been found in the fields or hedges, the facts that the caterpillars go down in the ground when full fed, that the empty pupa cases are found underground, and that in the insectary, if they are provided with earth, they pupate underground, show that they pupate about 2″ or 3″ underground in hedges and under trees. For passing a long period in the dormant stage, the caterpillars, after going underground, spin cocoons with the hairs on their bodies and pupate inside. They generally remain in this condition till the first fall of rain of the next monsoon, and so they have only one brood in the year. But exceptionally, if in the same season the rain stops altogether after the first fall, and if the weather remains hot till the pupæ of the present brood have passed about 12 days or a fortnight in that stage, moths emerge from them in the same season. In this case they have two broods in the year.

Imago.—Moths begin to emerge from the pupa, from the next day after the first fall of monsoon rain, and within 10 to 12 days all come out. The colour of the wings is white with a few black spots. The dorsal surface of the abdomen in some species is red and in others orange or dull red. There are three black spots, on each abdominal segment, arranged horizontally, the

middle one being bigger than the other two. The lower surface is dirty white, and there are two black spots arranged laterally on each abdominal segment. The length from head to tail is about $\frac{3}{4}''$ in the female and $\frac{1}{2}''$ in the male. They measure two inches and one and half inches across, respectively when on wings.

On the same day or on the next day after they emerge from pupa, the male and female mate; the former dies after mating, and the latter survives for a day or two, and dies after laying eggs. At dusk and at night they are found flying about, either in search of their mate or seeking a suitable place for laying eggs; and during the day they hide themselves in hedges and such other places where they can protect themselves against enemies. They cling to the leaves or twigs so firmly with their legs, that high wind is unable to blow them away, and it is not without some force that one can detach them from the leaf or twig. They are weak fliers and cannot fly to a distance of more than 20 to 30 feet in one flight. At night they are attracted to light.

Parasites.—The maggots of two kinds of Dipterous flies and one Ichneumon-fly, have been observed feeding in the bodies of the caterpillars. They have not yet been identified. In a swarm of "Katra," a great number of these flies can be seen flying about very close to the caterpillars, and it is presumed that they do so for depositing their eggs on the bodies of the hosts.

Predators.—The black crow and a kind of black sparrow, known in Gujarati as "vahi," are seen eating these caterpillars voraciously.

Remedies.—Keeping the habits of the insect noted above in view, the following suggestions are made for dealing with the pest, and one or all of them may be utilised according to the requirements.

I. Before the monsoon sets in, all the dirt and soil on the headlands of the fields should be collected and burnt. Along with this soil many pupæ are collected and burnt. This operation

is known in Gujarat as "burning sood" and is practised by all careful cultivators.

II. From the very first night after the first fall of monsoon rain, a lantern may be placed burning every night in the field and should be continued for about ten or twelve nights. As the moths that emerge are attracted to lights, it is easy to trap them in this way. For killing the moths, a tray half full of water mixed with about 5 tolas of kerosene oil may be placed below the lantern. All the moths that are attracted fall into the water and are destroyed by the kerosene. For diffusing the light over a wider area, the tray may be placed on a stand, a foot or two feet high; a small heap of earth will serve the purpose of a stand.

Where these insects appear in swarms every year, this method can be advantageously practised by mutual co-operation of cultivators, and if an organised effort is made once, the pest can be checked for some years.

III. For about a week just after the first rain the weeds and grasses grown on headlands should be examined, and if small "Katra" are seen in a great number, they can be isolated from the field by digging a channel about a foot deep all round. The Katras will fall into this trap and may be killed.

IV. If they have already entered the field, leaves of "Thoria" may be scattered into the space between the rows of the crop. They will feed on these leaves and thus the crop can be saved.

Light Experiment.

The light experiment was made in June last in a village named Kanial in the Atarsumba Peta Mahal, where the swarms of "Katra" appear every year.

Some fields of the eastern *sim* (area) were selected for this purpose, and a diagram of the fields is attached.

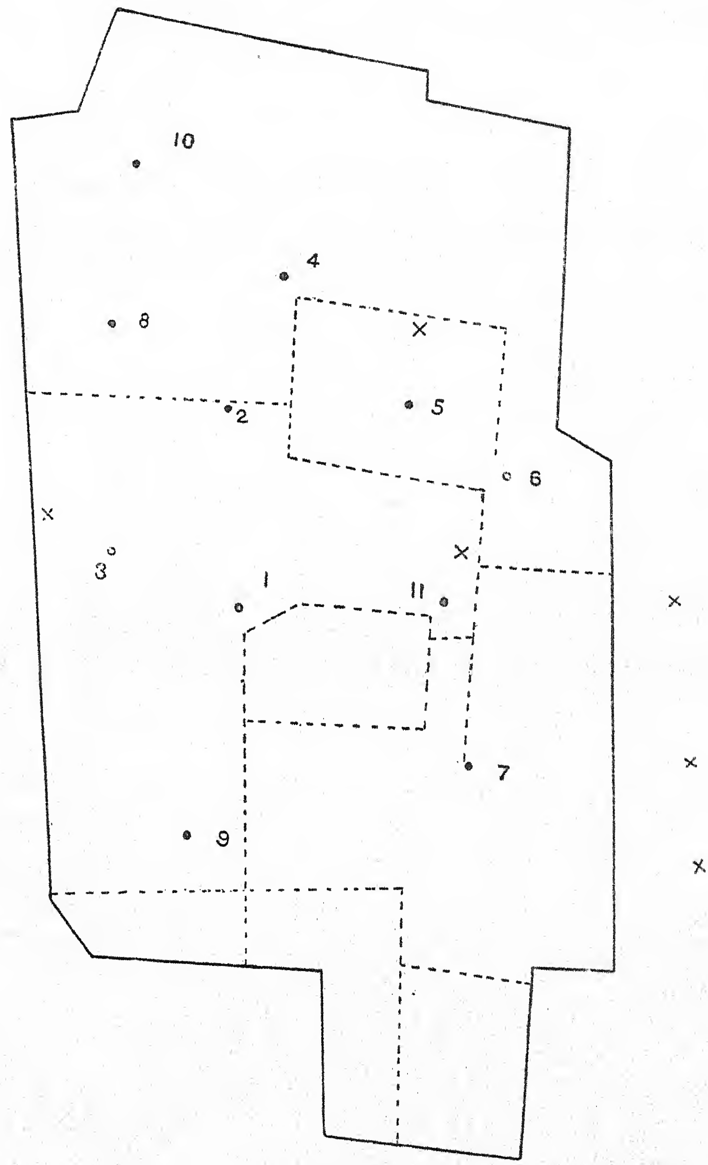


DIAGRAM OF THE FIELDS TREATED.

The continuous thick line in the diagram shows the boundary of the experiment, which encloses an area of 36 acres of land. The dotted lines inside this boundary represent live hedges. The points show the position of various lamps placed every night, and the figures used are the corresponding numbers of the lamps that

are used in the following paragraphs. The cross marks show the places where "Katra" appeared.

Two lanterns, Nos. 1 and 2, were placed burning at night on the 11th, 12th and 13th June 1907, and no Katra moth was found in the trays below the lanterns next morning. The first rainfall began at night on the 13th and it rained till the next morning. From 14th to 19th nine lanterns (Nos. 1 to 9) were placed at different places as shown in the diagram, and Nos. 10 and 11 were added from the 20th. All these were continued till the 2nd July 1907. The statement on page 159 shows the number of moths trapped at each lamp every night.

From this statement, it seems that all the moths that were likely to be trapped, were trapped within ten days after the first fall of rain. For fixing this period, one lamp was placed in a field far away from these fields on the 21st and 22nd. On the 21st, three moths were trapped, and on the 22nd, none was trapped. Again, on the 30th, a lamp was placed in a field of the adjoining village, and none was trapped at it. These outlying places were full of Katra. This phenomenon shows that where the lamps were placed, all the moths were trapped within 10 days, and where they were left alone, they laid eggs and died naturally in the same time after the first rainfall.

All the lamps were lighted at 7 P.M. every night and were extinguished at 5-30 A.M. next morning. For ascertaining the best time at which they come in large numbers, the moths attracted to each lamp were counted at different times during the night from 20th to 23rd June 1907, and from the analysis of these four nights, it seems that the best result is attained after 10 P.M.

As there was no rain for about 22 days after the first one, people were unable to grow any crops in the fields, and consequently the Katra, that appeared on weeds in the fields other than those treated, had not sufficient food for thriving. The excessive heat killed a very great number in their young stage. People had therefore no chance to compare the result of the experiment at a glance. However, those who were shown the

Detailed Statement showing the Moths trapped at each lamp every night.

Date and time.		Number of moths trapped at different lamps. I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	Total in the morning.	Particulars of rainfall.	REMARKS.
Morning of 15th June 1907.	...	...	...	...	1	...	5	...	...	...	Not lighted.	Not lighted.	6	Slight, previous night.	
16th June	...	90	39	65	76	45	112	180	105	87			799	*Nil.*	
17th June	...	39	8	4	69	8	13	1	20	12			174	*Nil.*	
18th June	...	15	3	10	32	5	4	3	4	1			77	*Nil.*	
19th June	...	2	...	2	4	...	2	2	2	3			17	Slight, early morning.	
20th June	...	...	...	...	1	...	2	...	...	...	...	...	3	*Nil.*	
20th night and 21st morning	7-50 P.M.	...	2	...	...	...	...	...	...	...	...	...			
	10 P.M.	...	...	...	2	2	1	4	...	...	...	1			
	After 10	11	8	4	29	15	14	18	...	1	5	14			
	Total	11	10	4	31	17	15	22	...	1	5	15	131	*Nil.*	
21st and 22nd	8 P.M.	1	...	...	...	...	...	...	...	...	...	...			
	10 P.M.	1	...	...	1	...	...	...	...	...	...	...			
	After 10	4	...	1	3	1	3	3	...	1	2	...			
	Total	6	...	1	4	1	3	3	...	1	2	...	21	Slight at intervals.	
22nd and 23rd	8 P.M.	...	...	...	...	...	...	...	...	...	...	...			
	10 P.M.	1	...	...	...	1	...	...	...	...	...	...			
	After 10	1	...	...	1	...	...	...	...	...	...	...			
	Total	2	...	...	1	1	...	...	...	...	...	...	4	*Nil.*	
23rd and 24th	8 P.M.	...	...	...	...	...	...	...	...	...	...	...			
	10 P.M.	...	...	...	1	...	...	...	...	...	...	...			
	After 10	...	...	...	...	...	...	1	...	...	...	...			
	Total	...	...	...	1	...	...	1	...	...	...	...	2	*Nil.*	
24th and 25th	...	...	...	...	...	...	...	...	...	...	...	...	...	*Nil.*	
25th and 26th	...	...	...	...	...	...	...	...	...	...	...	...	...	*Nil.*	
26th and 27th	...	...	...	...	...	...	...	...	...	...	...	...	...	*Nil.*	
27th and 28th	...	...	...	...	...	...	...	...	...	...	...	...	...	*Nil.*	
28th and 29th	...	...	...	...	...	...	...	...	...	...	...	...	...	*Nil.*	
29th and 30th	...	...	...	...	...	...	...	...	...	...	...	...	...	*Nil.*	
30th and 1st July	...			This night one lamp was placed in a field of the adjoining village.										*Nil.*	
1st and 2nd	...	...	...	...	...	...	...	...	...	...	...	...	...	*Nil.*	

experiment all along, were taken out in the fields, and they saw that there were "Katra" in the other fields and not in the area treated. Thus they were convinced of the effects of the experiment.

As regards the Katra that appeared near lamps Nos. 3, 5 and 11, it is presumed that at each of these three places a female moth, while flying to the lamp, might have dropped down to take rest and there laid eggs.

Cost.—In an area of 36 acres 9 Hinks' hurricane lanterns and two ordinary cocoanut oil lanterns were used. On an average of 5 days, the kerosene oil consumed was 15 tolas per lamp per night and the cocoanut oil consumed was 6 tolas per lamp per night. The total cost in oil for ten days would be Rs. 3 or Re. 0-1-4 an acre. This cost will slightly vary according to the number and extent of hedges, but it may be taken as a fair average.

INSECT PESTS OF MANGEL WURZEL.

By H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S.,

Imperial Entomologist, Pusa.

The Mangel Wurzel is not one of the ordinary crop plants in general cultivation in India: its cultivation has, however, been recommended owing to the valuable qualities of the plant, and it has been under experimental cultivation at Pusa during three *rabi* seasons. Like many exotic plants introduced to a new country, it has been severely attacked by insect pests, and this has occurred to such an extent that any one attempting to cultivate this crop will have to be prepared for their attacks and take them into account in dealing with it. Three insects especially attack this plant: Surface weevils are destructive to the young plants soon after they come up; Surface caterpillars are a constant pest throughout the cold weather, and finally, as the warm weather commences, the "Indigo caterpillar," so familiar to planters in Behar, may transfer its attentions to this crop, even in preference to lucerne and may do much to complete the damage done by the preceding insects.

Surface weevils are small, dull, grey weevils (*Tanymecus indicus* Desb.), so like the soil in colour that they are difficult to see; they are usually abundant at the commencement of the *kharif* and of the *rabi* seasons. At Pusa, their attacks on the young Mangel Wurzel were severe in two years out of three: they were not anticipated the first year and, by eating the leaves of the young plants, did a considerable amount of damage; strong growing plants survived and since the seed is thickly sown and the young plants must be freely thinned, the weevils

were not really injurious, once the young plant had a good number of leaves and was growing well up. In the second year, they appeared again and were kept in check by strewing the field with chips of any cucurbitaceous fruits (such as the various gourds, pumpkins, etc., grown in gardens), and examining these chips daily for the weevils which collected there to feed. A large number of weevils were destroyed in this way, but it is possible that there would have been no more had the area of the crops been very much larger and the damage would have been proportionately much less. The obvious precaution is to get the plants growing freely as early as possible in the season, so that the injury caused by weevils will not check the growth of the plants. The Imperial Agriculturist finds that sowing should be done in the latter half of October, and not later than the end of October, on land previously well irrigated, so as to secure full germination.

After the weevil, the ordinary Surface caterpillar appears. This insect has been fully described (see Vol. II, p. 42, of this Journal). If extensive injury is to be avoided in the bad years that come every now and then, these caterpillars must either be poisoned with baits or collected when weeding is being done and so destroyed. They will otherwise cut off so large a number of plants that the gaps will be extensive and will materially reduce the yield. This form of damage commences in December and if checked then, does not recur seriously in that season but, if left alone, there will be a more extensive attack in February, when gaps cannot be filled.

Finally, in March appeared the Indigo caterpillar (see this Journal, Vol. I, p. 338). In the last season this was so abundant as to wholly strip the plants of leaves, and though the attack came late, the roots could develop no more after the leaves were stripped off and in consequence never reached their full size. The caterpillars also, with the Surface caterpillars, in seeking food after they had devoured the leaves, eat into the roots at the surface of the soil. For this pest there is no practical cure, and the only precaution is to get the crop on as early as can be done, so that when the weather warms up in

March, the roots may have reached such a stage of development that the destruction of the leaves is immaterial and, should the eggmasses or young caterpillars be seen, the best precaution is to harvest the roots as soon as can be done. To the indigo planter growing Sumatra indigo, the predilection of the caterpillar for Mangel Wurzel may be useful, since, if he grows an acre or more of it, it will protect his indigo in the same way that lucerne does, only apparently more efficiently.

In the above account, we have referred to the pests doing damage only on a small area of five acres or less; this damage will probably be less, in proportion, the greater the area sown. It is clear that, in Behar, the crop is likely to suffer from insects, and that it is essential that it should be sown as early as possible and brought on quickly. These same pests occur over India generally, and in any experimental cultivation on the crop, they may be looked for. It is probable that continuous cultivation for a series of years would acclimatise the plant and render it less liable to the attacks of these pests, but as at present seed is not raised locally but is imported fresh yearly, the damage due to pests is likely to continue.

CULTIVATION OF COTTON IN INDIA.

By G. A. GAMMIE, F.L.S.,

Economic Botanist, Bombay, Kirkee.

[Paper read at the Industrial Conference held at Surat in 1907.]

History of Cotton.

The fibre which furnishes the staple article of clothing in India is scarcely mentioned in the early literature of the East, but this may be explained by the contemptuous indifference evinced by learned men to the products and necessaries of every-day life.

The Sanskrit word translated "cotton" is first mentioned in the Institutes of Manu, where it is enjoined that the sacred thread of a Brahmin must be made from cotton. Herodotus gives a clear description of the cotton plant, when he says that the wlid trees of India bear wool like sheep and the Indians use cloth made from these trees. Theophrastus describes a plant with a leaf like that of a black mulberry, the whole plant resembling the wild rose, and being grown in rows in the fields. The first mention of cotton as an article of foreign trade is by Arrian, who flourished in the first century. He says that the Arabs exported cotton to the Red Sea. From India the cultivation of cotton seems to have been spread westward as far as Southern Europe.

Cotton seems to have remained unknown in China until the 13th century. As the cottons of this country approach closely in appearance to those of Bengal and Burma, it is probable, that they, with tea, were introduced from India. In the New World,

where varieties of cotton distinct from these of India are produced, the product must have been used from the earliest times. The knowledge of spinning and weaving gradually extended westwards and reached England in the 17th century. In the early years of the last century the production of cotton in the Southern States of America was enormously increased, and this rise in importance of America as a formidable competitor induced the Directors of the Honourable East India Company to initiate the experiments for the purpose of improving the quality and quantity of Indian cotton for export to England.

Experiments to Improve Indian Cottons.

The causes of the decline in the appreciation of Indian cottons in the European markets have been often explained. As regards the intrinsic value of the staple, the superior kinds of Indian cottons compared favourably, on the whole, with the American short-stapled cottons. The average staple of Upland Georgian is between 1·00 and 1·02 inch, that of the best Broach from ·90 to barely one inch. The circumstances which tend to increase the inferiority of Indian cottons are carelessness in picking, which causes a loss of 2·5 to about 7 per cent. against under 2 per cent. of the American Upland Georgian. It must be remembered that the friability of the leaves of the Indian cotton plant is due to the drought of the picking season, so that, even with extreme care, it will never be quite possible to pick Indian cotton in a perfectly clean state.

Owing to the stronger attachment of fibre to the seed, Indian cotton is more liable to be injured in ginning than that of America and Egypt. The tenacious adherence of the fibre to the seed of course spoils the cotton in two ways, by the liability of the fibre to be cut and torn, and by the breaking or crushing of the seed from which oil exudes to stain the fibre. The high pressure to which cotton is often subjected in baling is said also to be detrimental to the quality of the fibre.

According to Watson, the native varieties of cotton may be divided into two principal groups ; the North-Western, yielding

about one-third of its weight clear cotton and including the Broach, Dholleras, Bhavnagar, Old Khandesh (*Varadi*) and the *Jari* variety of Umravati cotton; and the South-Eastern group yielding about a quarter of its weight of clear cotton and including the Hinganghat, the Bani variety of Umravati cotton, the Kumpta, Madras (Upum variety) and the New Khandesh cotton (from Hinganghat seed). The short-stapled Sind cotton, yielding rather more than a third of its weight of clean cotton, may be considered as forming a group apart. The varieties under the names of Western and Tinnevelly cotton, must have been yielded by the Bourbon variety, which has been acclimatized in the Madras Presidency since the beginning of the last century.

The four varieties which in point of quality proved superior to all the others were the Hinganghat, Broach, Kumta, and the Dharwar American cotton. The varieties next in order are the Khandesh, Western Dhollera, Umravati and Madras cotton, whilst the Sind cotton must be placed last of all.

The principal descriptions of Indian cottons according to Beaufort are Hinganghat (Central Provinces), Broach (Southern Guzerat), Dhollera, Bhavnagar (Northern Guzerat, Kathiawar, Cutch), Umravati (Berar, Khandesh, Deccan), Kumpta and Dharwar (Southern Mahratta Country), Sind (Sind), Bengals (Central India, Punjab, United Provinces, Bengal), Westerns (Sholapur and Northern part of Madras), Salem (Salem and Coimbatore), Coconadas (Kistna, Nellore, Godavari), Tinnevellys (Tinnevelly, Madras, Trichinopoly).

Two factors of inferiority in Indian cottons are staple and yield, and many experiments have been attempted with the express object of increasing the value of these. The most obvious and speediest solution of the difficulty, namely, the introduction of higher class American or Egyptian, was suggested at first, but long experience has shown that, except in some particularly favoured districts, no advantage whatever is gained from efforts in this direction.

Recent experiments point out that successful results will ultimately be arrived at by the exceedingly slow but certain

methods of selection. Theoretically no practical difficulties are anticipated in the establishment of farms to produce seeds of improved varieties in moderately large quantities, but the maintenance of these varieties, when they perhaps cover large areas in cotton districts, is a subject which has not yet been sufficiently discussed in all its bearings. Loyal co-operation on the part of cultivators and merchants will be necessary for many years to come. It is impossible for the members of a small Department to control arrangements beyond a certain point.

It must not be supposed that the cultivator himself is not fully alive to the importance of seed selection. Many farmers hand-gin the seed required for the following year's crop; some in suitable parts of the Dharwar district already find it to their advantage to introduce seed of a superior variety from Broach, others particularly reserve the green seeded form of Dharwar American, and in Khandesh the coarsest varieties are deliberately selected on account of their hardiness, productivity and higher percentage of cotton.

Taking into consideration the want of capital and the average small holding of the Indian farmer, any method of cultivation which would entail expenditure on artificial or farmyard manures, is at present out of the question. The general consensus of opinion of the expert cotton growers who conducted experiments in the cotton department, appeared to be that no improvement was to be expected from any alteration in the native methods of cultivating cotton, as the implements already used were extremely well adapted to the purpose. The defects complained of, as has already been shown, were due to faulty processes during and after harvesting the produce.

The experiments, however, in these early years, were directed with the purpose of introducing the finer exotic varieties into the country. This object was only attained by the establishment of the Upland Georgian into the Dharwar district and of Bourbon into parts of Madras. The sum of experience gained amounted to the fact that experiments with foreign cottons were often successful when conducted as costly garden trials, while, on transfer to

the fields, it was found the plants would grow so moderately as not to afford a reasonable profit to the cultivator. Further, the foreign cottons with naked seeds fell an easier prey to harmful insects than the native varieties, which, with one exception, have their seeds guarded by a dense covering of short hairs.

The universal result of the experiments may be summed up in the words of the report issued on those at Broach. "Some kinds of exotic cotton, such as the New Orleans and Bourbon, yielded occasionally a small crop when cultivated as garden plants with great care and expense, but they never escaped partial damage from the effect of the seasons. Where the same kinds were cultivated on a larger scale, even with the greater skill, labour and care of the experimental establishments, the crop invariably failed. The possibility of raising garden samples of any kind of cotton anywhere, by unlimited care and expenditure, is scarcely doubted, but the feasibility of doing so upon terms within the actual reach of the ryot and within the market value of the article, has not been demonstrated at Broach. It was proved that, by double the care and attention and more than double the expense of the native cultivation, a larger yield and better and cleaner quality might be obtained from the indigenous cotton than the ryots can produce, but not sufficiently so to repay the additional outlay."

This may be considered the final word on the subject, until the Agricultural Departments in India again took it under consideration. They have profited by the lesson that little can be gained by the introduction of foreign cottons which have to be subjected to a long course of acclimatization. The failure of tree cottons on a large scale, after their success has been completely established in garden trials, has been repeated, and the inevitable result should now be accepted as a fact, so that further loss can be avoided in the future.

The pursuance of a rigid system of selection on a scientific basis and the more intelligent appreciation of the laws which govern the production of crosses and hybrids will probably lead to definite results, at first on the seed farms and afterwards on the

fields. New varieties will be introduced into districts suitable in every way to their individual requirements of climate and general environment. The Agricultural Department can furnish the necessary scientific guidance, but nothing can be done on a field scale without the assistance of the farmer and trader.

Cotton Soils and Culture.

Black soils in India are pre-eminently the best for cotton. Red soils are scarcely ever used for this crop. The superiority of the black soil is probably due to its depth and adhesiveness, which render it very retentive of moisture.

Mr. Mercer made the following remarks regarding the state of native cotton culture: "In Gujrat, Khandesh, Southern Maratha Country and Berar, I find an approach to the American mode of culture, by sowing in drills and at regular intervals, while in Madras, the North-West Provinces and almost every other part of India where cotton is grown, the broadcast system alone is used. The first, by allowing the crops to be kept free from grass and weeds, by means of plough or cultivator, and the ground about the plants being thoroughly and constantly stirred, gives an advantage both in regard to cheapness and the improvement of plants themselves that the other never can possess, and is, indeed, the chief excellence of the American mode of culture and the only one of its features which has been found not to need much modification.

"It appears that the natives of large tracts, as Guzerat, Berar, already employ a mode of cultivating the cotton plant, in principle nearly the same as the American, but better suited in some respects to locality, etc. No people better understand the advantages of rotation of crops than do the natives of India generally. With regard to implements of cultivation, those now in use amongst the natives of the districts where the drill system of cotton culture is practised, are quite sufficient, being fully adapted to the most thorough tilling of the ground. Though the field for improvement is great, still, the manner of growing the cotton is not nearly so defective as it has heretofore been the

practice to represent." Previous experiments, carefully conducted, proved that irrigation, especially in the later stages, is harmful to the crop and weakens the fibre.

In conclusion, at the present juncture, we are only in a position to say tentatively, exotic cottons can only be cultivated in favoured parts of India ; tree cotton cultivation is not worth the risk ; varieties can only be improved in their own localities, by the adoption of methods of selection and crossing, and varieties can only be maintained in a pure state in the fields if the cultivators and traders are willing to observe the needful precaution.

NOTES.

Experiments in Treating Ground-nut Leaf Disease.—The disease known as *tikka*, caused by the fungus *Septoglœum Arachidis*, has been severe on the Government Farm at Kirkee, near Poona, for some years. Experiments in treating it by steeping the seed in copper sulphate and by spraying with Bordeaux mixture were started in 1905-6, and continued last season. The results were disappointing. No improvement in the treated plots could be detected on inspection and, though the yield obtained the first year appeared to indicate a beneficial result, this was not maintained the second year, and the variations between the plots were probably a result of differences in soil. The fungus forms quantities of spores on the lower surfaces of the leaves, and as the crop covers the ground closely, it is unlikely that any spray, however carefully applied, can reach many of the spore-producing spots. Hence, even sprayed plants may infect their neighbours, particularly during the monsoon when there is so much disturbance of the leaves. Steeping was tried although the parasite has not been found in the seed, because there is some evidence that seed from diseased plants may convey the disease. This is, however, likely to be due to casual spores lying in the soil which sticks to the outside of the nut, and such spores would be reached with difficulty by any fungicide. It is, therefore, advisable, when ground-nut seed is introduced into a new locality, to have the seed husked first and then treated with copper sulphate before exporting. There is another possible way in which the ravages of *tikka* disease may be lessened. Experience seems to show that early maturing varieties suffer least, for by the time that their leaves are severely affected the nuts have

been set and escape shrivelling. Hence attention should be directed to obtaining an early ripening variety of nut by selection or hybridization. This appears to be the most hopeful method of attacking the ground-nut disease at present available.—(E. J. BUTLER.)

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EGYPTIAN COTTON IN SIND.—In 1905, the area sown in Egyptian cotton was 1,000 acres; it was all on the Jamrao Canal situated in a district measuring 2,000 square miles. The yield was approximately 450 bales. The season was said to be unfavourable to all cotton in Sind. Very sanguine estimates were formed early in the season of the yield of this crop, up to an average of $1\frac{1}{4}$ bales per acre. While a small percentage of the area sown came up to the estimate, the larger portion was only fair and brought the average yield to a low level.

The price, however, obtained was very encouraging. Eleven bales were forwarded to Liverpool for valuation and were sold in the open market at 9*d.* per lb. The value of good fair Egyptian on the same day was 10*d.*, and middling American 6·04*d.*

The Vice-Chairman of the British Cotton-Growing Association wrote as follows:—"Under these circumstances it would be advisable to endeavour to get as much Egyptian cotton planted in Sind as possible this season, and the planters ought to be able to rely on a minimum price of 7*d.* per lb. out there."

Most of the cotton was bought by a Karachi exporting firm and the price obtained by the cultivators worked out at $5\frac{1}{2}d.$ for Mit-Afifi and $7\frac{1}{2}d.$ for Abassi. This firm was said to have obtained 11*d.* per lb. for this cotton in Liverpool.

In the season of 1906, the area under Egyptian cotton was 5,098 acres. It was, as in former years, scattered in small plots over a very large area. Consequently, in order that the zemindars might get as large a price as possible for their produce, it was considered necessary to establish a system of receiving depôts for the collection of the cotton. A central depôt was established at Mirpurkhas and there the cotton was auctioned. This scheme was successfully carried out by the Colonization Officer, Jamrao

Canal ; it was the means of greatly increasing competition. Even the worst quality cotton which was greatly discoloured by the attack of boll-worm sold at a rate of Rs. 11-2-0 per maund. This price compares favourably with the best given for Abassi and Mit-Afifi in the previous year.

It is probable that this system of collection and auctioning the cotton under Government supervision will have to be continued for some years till cultivation is fairly established and buyers fully aware of the nature of the produce.

The amount of Egyptian cotton actually sold at Mirpurkhas was 4,879 maunds (of 80 lbs.) of seed cotton and the average rate Rs. 11-15-0 per maund. Besides this, however, much cotton was disposed of by private sale to Ahmedabad spinners and to a Karachi firm for export.

The total yield was probably under 10,000 maunds of seed cotton. This low yield was generally explained by the ravages of the boll-worm, but if the cultivation in 1906 was similar to that practised by many zemindars in the current year, the low yield for the larger portion of the land is explained apart from the effect of boll-worm. Last year's ginned cotton, where not discoloured by boll-worm, seems to have been fully equal to average North Egyptian Abassi. The ginning results were also said to be similar, *viz.*, about 100 lbs. lint to 315 lbs. seed cotton. No complaint was made by spinners as regards length of staple ; the strength, however, was reported to have deteriorated.

During the season of 1907 the area sown was 6,335 acres. An area of about 2,000 acres was sown with Abassi seed obtained from last year's crop, ginned in Sind. The remaining area was sown with Mit-Afifi seed imported from Egypt.

In 1907, there was practically no boll-worm on the Egyptian cotton, but a considerable amount was found on Sindhi Cotton in the same districts. The cultivation was in most cases very poor ; many cultivators broadcasted the seed on the flat after one ploughing and paid no attention to thinning or weeding. In nearly all cases, too, the irrigation was excessive which is a certain means of lowering the grade of the staple. The results

of this over-irrigation was seen on the growing crop, *viz.*, large masses of foliage developed at the expense of bolls, and the ground became covered with weeds. In a few cases, very good crops were obtained as the result of more careful cultivation. There seems to be no reason why with proper cultivation and rotation returns of 1,000—1,500 lbs. of seed cotton per acre should not be obtained on land that is free from alkali.

As in the former season, the Government auctions at Mirpurkhas had a very beneficial effect in obtaining an adequate price for the cotton. As the stuff was exposed in fairly large lots, buyers came to Mirpurkhas who would not have gone round the district buying in small lots. Most of the cotton was sold by private treaty at slightly less than auction prices. As far as can be ascertained, the total crop was about 1,800 bales each of 400 lbs. Of this the auction disposed of about 55 bales of Abassi and nearly 300 bales of Mit-Afifi. The average price obtained was :—

Mit-Afifi, Rs. 11 per maund of 80 lbs. seed cotton.
Abassi, Rs. 13 per maund of 80 lbs. seed cotton.

Mit-Afifi being new to the Indian market, the buyers were probably discouraged by its brown colour. Similar seed cotton was being sold in North Egypt for £4-5-0 per 315 lbs.

Government fees for transport, etc., fall to be deducted from this at Re. 1 per maund. An average figure for total crop would be probably Rs. 11 to Rs. 11-8-0 per maund. The chief buyers were Ahmedabad and Bombay mills, chiefly for trial spinnings, and one or two exporting firms. It was also reported that samples were bought for export to Japan.

In the present season of 1908 the area to be sown is practically the same as last year. 56 tons of Abassi seed and 11 tons of Mit-Afifi seed are being distributed to the zemindars.—(G. S. HENDERSON.)

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BOARD OF AGRICULTURE IN INDIA, 1908.—The fourth Annual Meeting of the Board was held at Pusa from the 17th to the

22nd February 1908. Mr. J. Mollison, M.R.A.C., presided. Fifty-one members and seven visitors attended the Board. Besides the officers of the Imperial and Provincial Departments of Agriculture, the meeting was attended by the Director-General of Commercial Intelligence, Director of Botanical Survey and officers attached to the Agricultural Departments of Kashmir, Baroda and Mysore States. A few non-official gentlemen, interested in Indian Agriculture, were also present. Bengal, United Provinces, Punjab, Madras and Central Provinces were each represented by five officers of its Department of Agriculture. Bombay was represented by three of its officers, Eastern Bengal and Assam by four and Burma by two. All Directors of Agriculture except the Director of Bombay were able to attend. The subjects brought up for discussion were :—

(*a*) The form of Report of the Board's proceedings ; (*b*) the future constitution of the Board of Agriculture ; (*c*) Programmes of work of the Imperial, Provincial, and Mysore, Baroda and Kashmir State Departments of Agriculture; (*d*) the lines on which Entomological and Mycological work in the Provinces should be conducted ; and the general expansion of the different sections of the Departments of Agriculture ; (*e*) the best methods of bringing experimental work to the notice of cultivators ; (*f*) the extension of cultivation of fibre plants ; (*g*) the scope of improved Poultry-breeding in India. These subjects were largely dealt with by committees, whose able reports, as modified by the full Board, will be published in due course.

The most important discussion referred to the best methods of bringing the work of the Department in a practical way to the notice of cultivators. Many of the members evinced keen interest and many useful suggestions were made.

With a view to removing the necessity of sending students to specialise in England or other foreign countries, it was decided that the Pusa College, with a selected number of Agricultural graduates and distinguished Science graduates of Indian Universties, should start a post-graduate specialised course as soon as the College building is ready, in July 1908. The standard

curriculum of studies has been framed and rules of admission are now under consideration. They will be shortly published for the information of the public.—(EDITOR.)

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LAC FUMIGATION.—On harvesting the crop of lac grown at Pusa in the rains, it was found that practically every stick was infested with caterpillars (several species of *Eublemma* and some *Tineids*). These feed on the lac insects and the lac, causing great loss in weight and are a well-known pest in India. The sticks were accordingly scraped at once and the lac spread out in the sun to dry. This being of no avail at all, the next batch of sticks, as they came from the trees, were placed in the fumigating box and treated with carbon bisulphide. The liquid was used at the rate of one ounce to ten cubic feet for twelve hours and on scraping the lac from these sticks, no live caterpillar was found but abundant dead caterpillars and chrysalids. The previously scraped lac was then treated in an ordinary box, the liquid being poured on to a wad of cloth placed at the top of the box and the box then closed. This treatment should either be double the strength of that used for the sticks or continued longer, and it is advisable to keep the box closed until the scraped lac is to be sold. That is, every filled box of scraped lac should be fumigated as it is, and kept so as long as possible. Lac treated in both ways was sent to Mirzapur for valuation and the traders were unable to discover anything wrong with the lac, valuing it at the prices then ruling, Rs. 43 and Rs. 30 per maund for the two qualities. The treatment is, therefore, not in any way injurious to the lac and the saving it effects is wholly out of proportion to its cost. Both the rains crop of lac and the cold weather crop are habitually attacked by caterpillars, the former most; such lac becomes wholly valueless and a specially good sample of lac sent by a planter from Assam to London was reported on as "wholly unfit for sale owing to worms." It is improbable that any means of checking these worms in the growing lac on the tree will be found, but it is at least possible to at once treat every stick of lac as it is

cut, and prevent the loss as soon as possible. We would draw the attention of every lac grower and lac buyer to this point and to the simple and easy treatment that is effectual.—(H. M. LEFROY.)

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TRAVANCORE COCONUT DISEASE.—Heavy loss has been incurred in Travancore in recent years owing to a disease of coconuts which affects a considerable area in the north of the State. This disease is spreading slowly and may appear in Malabar before long. It causes the trees gradually to become barren ; in some gardens the best trees, that used to give over a hundred nuts a few years ago, now only give ten or twenty or even sometimes none at all.

The first sign of this disease is that some or all of the leaves turn yellow, as if they did not get enough water. Then the tips of the leaflets dry up and hang down. At the same time the outer leaves bend away from the crown and become loosened, so that they can easily be torn off from the tree. In a year or two from the first appearance all the leaves turn yellow and dry up at the tips. When this happens, the bunches of nuts get affected ; at first some of the nuts do not ripen properly but fall to the ground in an immature condition ; next year there will be fewer and smaller nuts, and after four or five years there may be none at all. Sometimes the flower spathes are unable to break out from the base of the leaves ; usually, however, they are formed but are not strong enough to produce good nuts. Such nuts as are given by diseased trees are of bad quality, the copra is hard and gives little oil and the water inside the nut is disagreeable in taste and diminished in quantity.

Gradually, as the palm gets more and more weakened, the new leaves that are formed are smaller than those of healthy trees. The centre shoot, which stands straight up in the middle of the crown, gets shortened and turns yellow or may even wither completely.

After five or ten years the diseased palm may dry up altogether and the head falls off. This is fairly common in some places, as in the Minachil Taluk of Travancore, while in others,

as at Changanacherry, very few trees have died even though some have been barren for many years.

Areca palms are attacked in the same way. As they are smaller and more delicate than coconuts, they become barren more quickly and they may be killed in from three to five years, though often they remain barren for much longer without dying. They are never killed in a few months as in the *Koleroga* disease which attacks areca palms in Mysore.

This disease has caused such losses in some villages in Travancore that there is now only one-quarter of the yield of coconuts that there used to be some years ago. The exports of coconut produce from the State have decreased in value by many lakhs, in spite of a considerable rise in price

It is caused by a minute fungus which attacks the roots in the soil and causes them to rot. This lives and grows in the soil, but can only spread underground very slowly. It has taken about ten years to get from one village in Travancore to another only a few miles away. If soil from a diseased garden is put into a healthy one, the fungus may be brought over in the soil, especially if it contains any coconut roots, and may begin to attack healthy trees at once. This must be the way that it has spread over a large part of North Travancore in the last twenty years, for in this manner it can, of course, be made to travel quickly. Hence, people should be very careful not to let any soil or roots from a diseased garden into their gardens.

The only way to kill the fungus is to dig up and burn the roots of diseased trees as soon as any are noticed. If all the owners of coconut and areca gardens in districts adjoining Travancore will do this, there is a good chance that the disease will not spread beyond the State. It will require great watchfulness and all must unite in keeping a lookout for cases, for if a few trees are left diseased, they will serve to harbour the fungus and enable it to spread in the soil and attack all the palms near by. The trees should be dug up and the roots burnt as soon as they are noticed to be diseased, as even though the owner may lose a few nuts by digging up the palm, the loss will be small,

and he will save his other trees. The palms do not seem ever to recover and it is better to lose a little at once than a great deal later on by allowing all the trees to get attacked.—(E. J. Butler.)

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Jute Experiments in Bengal.—The Bengal Agricultural Department Leaflet No. 1, 1907, gives the general results of jute experiments which were begun on the Burdwan Agricultural Station in 1904 and have been carried out there and elsewhere in Bengal up to date The Burdwan experiments have definitely proved that of 57 varieties originally tried, 10 are the best. When the rainfall is normal and well distributed, no irrigation is required. The best time for sowing seed is the third week of April or a little after. The seed must be sown in a smooth seed bed which can only be produced by a large number of ploughings and other cultivation. The crop is exhaustive and requires considerable dressings of manure before the seed is sown. The most paying results at Burdwan were got by applying 70 maunds of cattle dung or $7\frac{1}{2}$ maunds of castor cake per acre. The plants should be thinned out to 4″ apart and reaped in September when the water conditions for retting are better than later. The longer the crop is allowed to grow, the heavier the outturn of fibre. It never pays to cut the crop before it is in full flower. The best quality and greatest outturn of fibre are probably obtained when the fruits are being formed.

Drilling of seed has so far failed to show any advantage over broad-casting, both systems being equally good. The following varieties, *viz.*, Baran of Mymensingh, Amonia of Faridpur, Kakya of Bombai and Deswal of Sirajganj, Barapat of Jagannathganj, Nailta of Mymensingh, Paknallya, Tosha of Pabna, Halbilati of Tipperah and Tosha of Faridpur have proved to be equally good and have yielded nearly the same quantity of outturn.

The experiments at the Cuttack Farm showed that under proper treatment jute can be successfully grown in parts of the Orissa Division in rotation with either paddy or potatoes.—(Editor.)

NOTE ON SOME SHEEP FOUND NEAR CUMBHUM.—On January 31st I visited Cumbhum in order to see some sheep which had been noticed by the Inspector-General of Agriculture from the train, when passing through, some days previously. The noticeable feature about them was their whiteness. I found the flocks some little distance from Cumbhum itself, grazing on the gravelly upland soils, where there were a few weeds and a little Sazza (*Pennisetum typhoideum*) and Varagu (*Panicum*) stubble. There was also a bit of dried grass on the lower slopes of the hills. The sheep were large, standing about 24—27 inches at the shoulder. The colour was mostly a very pale brown but there were many practically pure white. A few were dark brown. This colour is often more marked on the belly and the back of the hind legs. They possess no wool at all but only a very coarse hair which is longer on the underside of the back and belly and on the hams. They possess small flaps of skin such as are found in goats. The rams have short and slightly twisted horns. They are accordingly mainly used for manurial purposes, though their flesh is eaten by the Mahomedans who are fairly numerous in this district. These sheep have little value except for their skins and indeed resemble goats somewhat closely.

The rams at the time of my visit were in a separate flock. They are allowed to run with the ewes in May or June. The lambs are dropped in October and run with the ewes for six months.—(R. CECIL WOOD.)

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BUNT IN WHEAT.—A sample of wheat flour, containing numbers of brown, smooth-walled spores, was recently received at Pusa from Gilgit. A few heads of local wheat obtained from the same locality showed that these spores belonged to the well-known "stinking smut" or "bunt" fungus, which causes considerable damage to wheat in some countries. This disease was not previously known to occur in India, or on its borders. Two varieties are found, under the names, *Tilletia Tritici* and *Tilletia lævis*, both of which were present on the Gilgit samples. Probably the latter is more common, as the spores in the flour

were almost all belonging to this variety Smutted heads are usually erect and can be detected when the crop is nearly mature. The fungus itself is not, however, visible until the grain is broken, when the interior is found to consist of a blackish, hard mass, with a very disagreeable odour. The disease can be almost entirely prevented by steeping the seed in formaline. A pint of this should be added to 50 gallons of water and the seed-grain immersed for four hours, then dried before sowing. A careful watch should be kept for this disease in the Punjab, as the experience in most countries has been that, unless checked, it gradually increases until it may cause severe loss.—(E. J. Butler.)

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Sericulture in Kashmir. (Note from the Report for 1907 of the Silk Association of Great Britain and Ireland).—The development of sericulture in Kashmir has been very striking during the last ten years. This industry is now probably the largest of its kind in existence. The report states that the mulberry tree is now being systematically cultivated in Kashmir. Silkworm eggs were given out to 15,784 householders. The women and children were chiefly engaged in rearing the silkworms: 60,000 to 70,000 persons were thus employed. The cocoons are brought to the Central Factory at Srinagar and paid for at fixed rates. In this factory the silk is reeled and over 6,000 men, women and children are employed at the work. The profits to the Kashmir State from this industry are year by year increasing. The progress is indicated by the following figures :—

The outturn of raw silk for	1900— 57,921	lbs.
" " "	1901— 90,648	"
" " "	1902—135,221	"
" " "	1903—146,087	"
" " "	1904—132,451	"
" " "	1905—152,425	"
" " "	1906—190,786	"

The raw and waste silk find a ready sale in France and Italy.—(Editor.)

***

A New Source of Sulphate of Ammonia.—A new source of Sulphate of Ammonia has been found in peat which exists in

immense areas in various parts of the world. The process by which Sulphate of Ammonia is obtained from peat is called the Wottereck process. The patentees are the Sulphate of Ammonia Company, Limited, of 171, Queen Victoria Street, London, E.C. By this process 585 tons of moist peat, equal to 200 tons of theoretically dry peat, gave a minimum yield of 10 tons of Sulphate of Ammonia. The maximum cost was found to be £5-8-0 per ton, which is less than half the present market price, £12-0-0 per ton. The destructive distillation of peat produces paraffin, tars, acetic acid and ammonia, which, after being separated, can be sold as commercial products.—(EDITOR.)

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* *

SELECTION OF PIGEON-PEA FOR WILT DISEASE.—Experiments were commenced at the Kirkee Government Farm, near Poona, in 1905, to raise a strain of *tur* (pigeon-pea) resistant to the wilt disease of this crop. A number of varieties were collected and sown on a plot that had been severely affected the previous year. Nine of these varieties, which showed promise, were resown on the same plot in 1906. As the seed was taken only from plants that survived the first year and were therefore presumably somewhat resistant, a higher proportion of survivals was anticipated in the second year. This was actually the case in seven out of the nine varieties, one remaining constant and one showing a decrease in resisting power. Work will be continued with a limited number of plants, and in a year or two it should be possible to select individual plants that are unquestionably resistant to the disease. Selection work of this nature is a more tedious matter than selection for definite qualities such as early ripening, colour or the like, since it is necessary to make reasonably sure that the resistance to disease is inherent, and not merely due to the parasite failing to come in contact with the plant. This is more difficult in the case of a soil-borne disease, such as wilt, than in others, as the degree of spread of the fungus through the soil cannot readily be gauged. As the parasite is widely distributed in soils which have grown pigeon-pea regularly, and as it enters into the interior of the underground parts, no

other method of checking it appears to be practicable than that here referred to. Whether this will be successful cannot be foretold at present, but the experiments are promising so far as they have gone.—(E. J. BUTLER.)

* * *

FLAX AS A FIBRE CROP IN BEHAR. A REVIEW OF A REPORT OF MR. EM. VANDERKERKOVE, FLAX EXPERT.—This crop has been grown experimentally for several years in Behar. The chief experiments have been conducted at Dhooria. The cultivation of flax on this estate in 1906 and in 1907 was on an extensive commercial scale. The 1907 crop was grown under the direct supervision of Mr. Vanderkerkove, who is a practical flax expert. He was engaged for a year by the Indigo Planters' Association, helped by funds provided by the Bengal Government. Mr. Vanderkerkove's report on his year's work is reviewed as under :—

Soil and Season.—The value of a flax crop is largely determined by the character of the soil and of the soil moisture. The best market rates can only be got if the stems are uniform in length, colour and flexibility. In Behar the light sandy soils and the heaviest clay soils will not usually produce a crop of this quality. Soils intermediate between these two are generally best, but this depends upon seasonal conditions. If the Hastha or Hathia rains in September-October are good, fairly light high land may be found suitable. If the October rainfall is deficient, low-lying clay-like land may probably be best. The important point is that the land should hold sufficient moisture near the surface at the time of sowing to secure even germination.

Cultivation.—Flax can only be grown successfully in the *Rabi* season. It can follow a monsoon crop which is taken early off the land if by ploughing and other tillage a clean friable seed bed for the flax is produced before the middle of October. It is unlikely that flax can be grown on the same field oftener than every fourth year. The land should be in good heart from previous manuring. Direct manuring for this crop is not advisable. European experience indicates that a liberal dressing

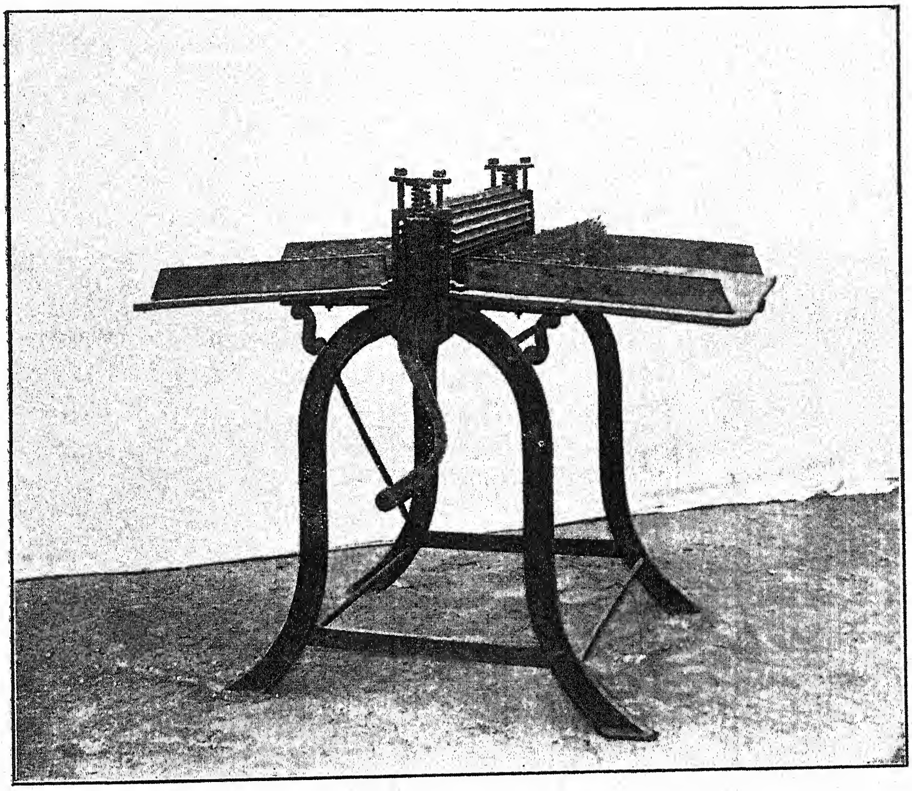
to the previous crop of a general manure, such as cattle dung, indigo refuse (seet), or oil cake would give good results. This dressing should be at least 8 tons of cattle dung or seet, or half a ton of rape or castor cake per acre (these are usually the cheapest manures in Behar).

Seed.—There is no doubt that imported seed should be used in the first instance. Mr. Vanderkerkove considers that Russian seed acclimatised for one year in France, Belgium or Holland may give the best results. There is, however, clear evidence that Russian or Belgian seed imported direct gives good results, and that such seed acclimatised in India continues to give good results at least for some years. The seed acclimatised in India is smaller than that imported. A seed rate of 120 to 150 lbs. of imported seed, or of 100 to 130 lbs. of acclimatised seed per acre, is required when both kinds are of good germinating power. The seed should be sown in October or at latest in the first week of November. The seed may be broadcasted by hand or drilled like indigo in very narrow rows, and could probably be very expeditiously and successfully sown by the cheap hand barrow for sowing broadcast which is so extensively used in sowing clover and grass seeds in England. It is best to sow in the early morning before the sun dries up the surface moisture. The seed should as far as possible be covered by light raking, afterwards the soil should be "rolled" down with a light log to conserve moisture. These operations are very essential to even germination on which the success of the crop greatly depends.

Weeding.—The land should be so carefully tilled before sowing that little weeding will be required afterwards. Hand weeding where necessary is essential. A bullock hoe cannot be used. The hand weeding should be done when the seedlings are small. When the seedlings are three inches high, it does more harm than good on account of the damage done by trampling. Clean seed should be sown to avoid as far as possible the need for weeding.

Maturing and harvesting.—Flax in Behar is usually a four months' crop. It reaches maturity for fibre when the first seed

PLATE XXIV.



A. J. I.

A Flax Breaker.

The woody portion of the retted straw is broken up by the grooved rollers of this machine. The little pieces of wood are then so loosely adherent to the fibre that they are completely detached in the scutching process.

bolls have fairly set. At this stage the amount of seed obtainable is small, but the quality of the fibre is superior. The usual signs of ripening are that the stems begin to get yellow, that the bottom leaves of the stems become yellow and begin to drop off, and that some of the bolls contain seeds which are beginning to get brown in colour. In an uneven field these signs may appear in patches. When they do appear, the crop should be uprooted patch by patch, immediately. The Indian cooly knows how to do this work because he is accustomed to it with other crops. The roots should be shaken free of earth and the stalks laid neatly in rows or "swathe" and allowed to dry for two or three days. The crop should then be tied into small-sized sheaves. If possible, the coarse and fine, the long and short stalks should be tied in separate sheaves. This helps in sorting the different qualities of fibre when it is being scutched. When sufficiently dry, the crop should be carted to the threshing floor in order to separate the seed by beating the sheaves with sticks or by beating them against a hard floor. The seed can be cleaned by wind in the ordinary way. Only the best seed should be kept for sowing. It can be safely stored in tins or closed earthen-ware *chatties.* It is necessary to protect the seed against weevils and absorption of moisture which cause great loss to the germinating power.

Quality.—The characteristics of good quality in flax are straight yellow slender stems, small white roots, very few branches and pods, small, soft leaves which are far apart, stems flexible towards the root and 28 to 36 inches long between root and top. Any length less than 18 inches of unbranched stem is useless except for tow. Coarse fibre of low market value is got from flax which remains green too long, which branches out freely and from which the stem leaves do not drop off when matured. A variety with these characteristics yields seed freely. The characters referred to in this para. should be specially studied in seed selection.

Retting.—There are several systems adopted in Europe, *viz.:*—

(1) River retting.
(2) Dew retting.
(3) Stagnant water or "blue" retting.

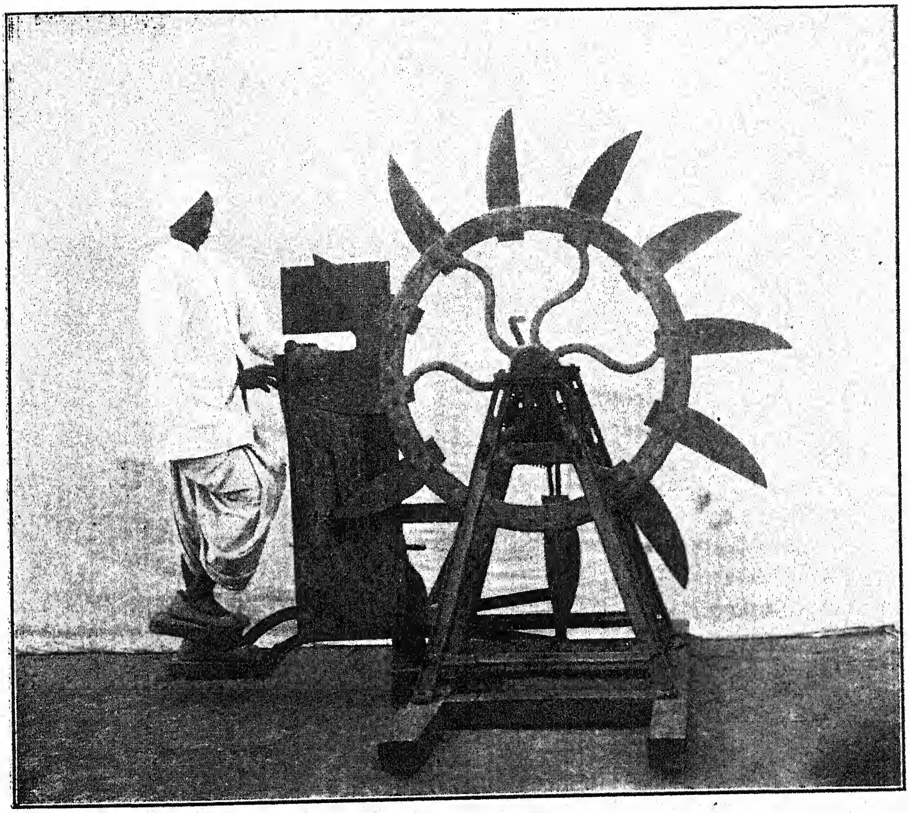
(4) Tank retting with underflowing water. (Loppersium patent.)

(5) Tank retting with washing system. (C. Vanstcenkiste patent.)

(4 and 5) are imitations of river retting.

The flax expert found 4 and 5 unsuitable to India and found it inconvenient to try the others. He decided that it was best to use ordinary indigo vats. The vats should be loaded with sheaves on end as evenly as possible, a second layer being placed above the first in the same way, and both kept in position by a close layer of bamboos on the top; cross beams 4 or 5 feet apart are rigidly kept in position about a foot above the loaded flax. Water is let in until the rising flax reaches the rigid beams. The water should cover the flax. The dissolving of the gums of the flax causes the water to become dark brown in colour; when the water becomes too heavy laden with dissolved matter, the retting bacteria cannot live in it. Consequently the brown water is let out at the bottom of the vat. Fresh water is let in at the top until the effluent water becomes fairly clear. If this fresh water gets also brown in colour, a portion may also have to be renewed before the first retting is complete. Generally, coarse straw which is stained by being laid in the field can be retted quicker than straw of better quality. The warmer the water is, the quicker the retting is accomplished. The best temperature is between 64° and 75° F. Water at 80° F. is not unsuitable, but at 90° F. is risky for good results. It takes six to ten days to ret the best quality of fibre. The process is considered complete when the bark and fibre layer cracks slightly by pressing the stem between the fingers. The water is then drained off and the flax is removed to the open to dry, great care being taken in handling it whilst wet to prevent damaging the tender fibre. When dry, it is again brought to the vats and again loaded as before. When the water gets brown, it is allowed to run off and clear water let in for a few hours until the retting is finished. The test is to break a stem in two places and draw out the fibre between these two points. If it comes out very easily, the retting is complete

PLATE XXV.



A. J. I.

FLAX SCUTCHING MACHINE.

The blades of the large wheel which revolves rapidly pass close to the broad vertical board. A slight rubbing action is thus imposed on the broken straw placed between them, which is sufficient to remove woody matter, "tow," etc., without unduly damaging the fibre that remains.

The object of twice retting and once drying in between is to improve the quality and colour of the fibre by bleaching in the sun and exposure to the air. Retting is best done in Behar in the cold season as the temperature of the water is then usually just right.

Drying.—The sheaves of flax are now removed to an open space, preferably to grass land, to dry. Each sheaf is divided into two or three parts. Each part is bound at the top end and spread out at the bottom end and is set on the ground in the shape of a cone. These cones are turned inside out next day and again set up to dry, the whole object being to expose to the sun and air, all the stems, so that they may dry and bleach thoroughly. When completely dry, the flax should be tied up into neat bundles, keeping all the root ends as even as possible.

Breaking.—This consists in passing the flax in very even handfuls between two sets of fluted iron rollers. These break the woody part of the stem and do not damage the fibre. Breaking facilitates scutching. A hand-power machine is illustrated. (Plate XXIV.)

Scutching.—A scutching machine can be worked by manual foot power or a number can be worked from a power shaft. The construction is difficult to describe—8 or 10 hard-wood blades about $\frac{1}{6}$ inch thick, fixed like the spokes of a cart wheel on a hub revolve at a high rate of speed on a shaft. In revolving, they pass close to a hard-wood board fixed in an upright position close to the revolving blades.

In this board there is a slit. Through this slit the flax with a firm grip is passed in and withdrawn in handfuls—first, one end of the handful and then the other. The process is repeated until the fibre is beaten clean. In scutching, a considerable amount of tow is produced, which has to be separated from the cleaned fibre. The cleaned fibre is graded according to quality, twisted and formed deftly into bundles. The scutching should be done before the flax becomes over-dry and brittle. In Behar the cold weather, from November to 1st March, is the best time. Mr. Vanderker-kove has been able to train ordinary coolies to do the work

expertly. A foot-power scutching machine is illustrated. (Plates XXV and XXVI.)

Baling.—The cleaned fibre is carefully graded according to quality. Each graded lot should be baled separately. This work requires expert knowledge. The bales for shipment are covered with gunny cloth, and each should be distinctively marked, to denote the quality of the fibre which it contains. The market rates vary largely. The very best qualities of flax always command very high prices.

Results of Dhooriah Experiments.—These indicate so far that flax is likely to become a paying crop on a commercial scale in Behar. The net profit from an acre of flax is estimated as follows :—

Outturn.

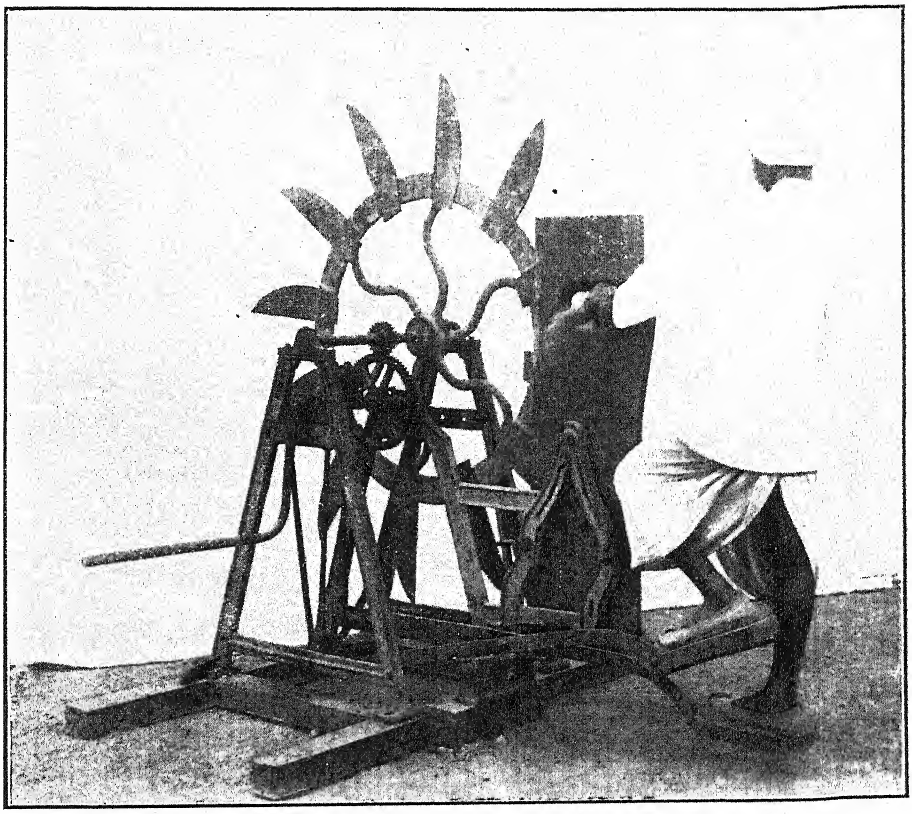
		Rs.	A.	P.
4 maunds of fibre @ £50 a ton	... ...	111	1	5
1·6 „ tow @ £15 „	... ...	13	5	4
4 „ of seed @ Rs. 4 per maund	... ...	16	0	0
		Rs. 140	6	9

Deduct cost.

		Rs.	A.	P.	Rs.	A.	P.
1. Rent	... ...	2	8	0			
2. Cultivation	... ...	27	0	0			
3. Securing crop	... ...	4	11	8			
4. Preparing for retting	... ...	3	5	0			
5. Retting	... ...	3	2	10			
6. Scutching, inclusive of tow	... ...	7	2	6			
7. Shipment	... ...	16	14	0			
8. Miscellaneous	... ...	1	4	0	66	0	0
Net profit					74	6	9

Future work.—The experimental results have been so encouraging that Mr. Vanderkerkove has been engaged for a term of years. The experimental work which has yet to be done covers a wide field. It will include the testing of (*a*) indigenous and exotic varieties, (*b*) acclimatization of improved seed, (*c*) plant-to-plant selection of seed, (*d*) soils, (*e*) rotation, (*f*) cultivation, (*g*) manures (including its own seet water), and (*h*) retting methods. Demonstration will be made to show whether the crop can be produced profitably in other parts of India and is within the means of ordinary cultivators. The best methods of baling and marketing the crop will be further examined.—(EDITOR.)

PLATE XXVI.



A. J. I.

Flax Scutching Machine.
Showing details of Construction.

REVIEWS.

Lac Cultivation in India. (Indian Trade Journal, Vol. VIII, No. 102.)

The chief factor in successful Lac production lies in the improving and systematizing of the cultivation. When experience has shown which tree suits a certain locality best, efforts should be made to establish regular areas of coppice, either from seed or cuttings, to be worked on a definite rotation. Various trees are suitable for Lac cultivation, *e.g.*, *Cajanus indicus* (Arhar Dal) in Assam, on which the best Lac of the Province is produced. This tree too has been found very useful in inoculating other trees such as Pipal, Ber, etc. The cost of cultivating 100 trees, say, of Kusum (*Schleichera trijuga*) is Rs. 15, and at lowest estimate this ought to produce 5 mds. of Lac (best orange shellac is made from Kusum Lac). The present price of Lac is Rs. 60 a maund; thus, there is a good margin for profit. Inoculation of brood Lac should always be from dense wood to less dense wood. A moist situation is essential for successful Lac growing.

Lac was produced in former times on account of its dyeing qualities, now its value lies solely in its resinous properties. The old method of collecting, which was suitable when 'dye' was the chief object, is nowadays harmful, giving a material of dirty and poor quality. On account of the extensive use of shellac in electrical works and in the manufacture of gramophone records, etc., the price of Lac has risen from Rs. 15 to Rs. 60 a maund. For those interested further information may be had from Mr. Stebbing's "Note on Lac Insect"; Dr. Watt's "Lac and Lac Industries" (Agricultural Ledger IX of 1907) and Indian Trade Journal, Vol. I, pages 102 and 437; Vol. III, page 294; Vol. IV,

pages 9, 380, 563; Vol. V, page 19; Vol. VI, page 733.—(W. Roberts.)

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Lift Irrigation. By Alfred Chatterton.

In this pamphlet, specially written for the Industrial Conference held at Surat, Mr. Chatterton demonstrates the efficiency of oil engines and pumps over indigenous water lifts for irrigation. This pamphlet is written in a simple style suitable to the intelligence of ordinary readers. He mentions the difficulties preventing the wide-spread use of oil engines and pumps. He admits the cultivator in India is generally poor and lacks mechanical skill. As it is not within the means of the cultivator to pay Rs. 2,000, the minimum cost of a pumping installation, he suggests that Government should purchase oil engines and pumps and make loans of these on the security of the farmer's crops. Owing to the limited mechanical skill of the ryots, Mr. Chatterton considers the centrifugal pump most suitable. It is extremely simple and fairly efficient and can be had at a very moderate price. Still, there is a further difficulty to contend with, *viz.*, that the supply of water should regularly be not less than 10,000 cubic feet a day for the greater part of the year. Mr. Chatterton, from his experience in the Madras Presidency, says that this quantity of water can be easily obtained in the coast districts, in the beds and along the margins of many rivers. If the oil engines and pumps are generally to replace native contrivances for lifting water, a preliminary survey of subterranean water should be carried out in all parts of India and the results should be made accessible to all cultivators.—(Editor.)

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Cross-Fertilization of Sugarcane.—("Cane Sugar or Beet.")

In a recently issued pamphlet, entitled "Cane Sugar or Beet," written by Mr. F. I. Scard, F.I.C., the writer gives a résumé of the advantages of the new system of cross-fertilization of definite varieties of canes over the older system of seedling cane selection.

Until recently propagation of cane from seed was not thought of, but recent researches have shown that although cultivation diminishes the fertility of the seed, it is possible to raise canes therefrom. This rediscovered power is now used to raise new varieties, which till recently could only be done by careful selection. The tendency of the cane to throw back to its original parents is shown very forcibly when it is grown from seed. The dozen or so of new varieties now cultivated in the West Indies have no doubt been selected from hundreds of thousands of seedlings. Recently, however, efforts have been made to cross-fertilize known botanical varieties, until lately thought impossible. In this way much labour will be saved and the lines of work will in future be much more definite, though the tendency to atavism will no doubt cause some trouble.—(W. Roberts.)

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Experiments with Calcium Cyanamide.

In the February number of the "Journal of the Board of Agriculture" Mr. A. D. Hall describes some experiments carried out at Rothamstead with the new nitrogenous manure, Calcium Cyanamide.

The object of these tests was to find out (*a*) whether, in view of its hygroscopicity, it could be stored under ordinary conditions in bags in a manure store; (*b*) whether there is any danger of acetylene gas being produced from unchanged Calcium Carbide remaining in the manure; (*c*) whether there is any loss of fertilizing value when it is mixed with other manures, particularly Superphosphate. From a sample of ordinary commercial Calcium Cyanamide containing 17·24 per cent. of Nitrogen, small quantities were taken, spread out on watch glasses, and placed under a large bell jar over water. Two watch glasses were withdrawn weekly; one was weighed in the wet condition and the other dried in the steam oven, and the amount of Nitrogen in each sample determined. It was found that in a sample which had gained 67 per cent. of moisture the loss of Nitrogen was only 0·37 per cent. To ascertain the gain in moisture under practical

conditions, a bag containing a known weight of Cyanamide was placed on the floor of an ordinary manure house. After 2½ months, it had only gained 5 per cent. in weight due to moisture, so the loss of Nitrogen in this case would be imperceptible.

Tests were also made to determine the amount of free Calcium Carbide in the Calcium Cyanamide. One sample was found to contain 0·048 per cent. and the other 0·062 per cent., quantities which are negligible, as the amount of inflammable gas which could be produced would be infinitesimal.

Superphosphate, being the only manure containing free acid in quantity, was selected to try the effect of mixing with Cyanamide. Three separate lots of Superphosphate, each of 2 cwt., were taken and mixed with 11 lbs., 22 lbs., and 44 lbs. of Cyanamide respectively. A considerable amount of heat was generated, due to the slaking of free lime in the Cyanamide, but no offensive gases were given off, although the operation of mixing was rendered unpleasant at first by the extreme dustiness of the Cyanamide. In another test, water was sprinkled on the heap while mixing was going on, and this kept down the dust, and considerably reduced the temperature. Samples from the mixtures were taken and analysed. It was found that there was no Nitrogen lost, any ammonia that is generated on the slaking of the lime being fixed by the Superphosphate ; that in a mixture of 1 part Cyanamide to 5 parts Superphosphate all the water-soluble phosphate is converted into dicalcium phosphate, insoluble in water but soluble in dilute citric acid ; and that very little change to tricalcium phosphate is brought about, so the loss of fertilizing value is very slight.

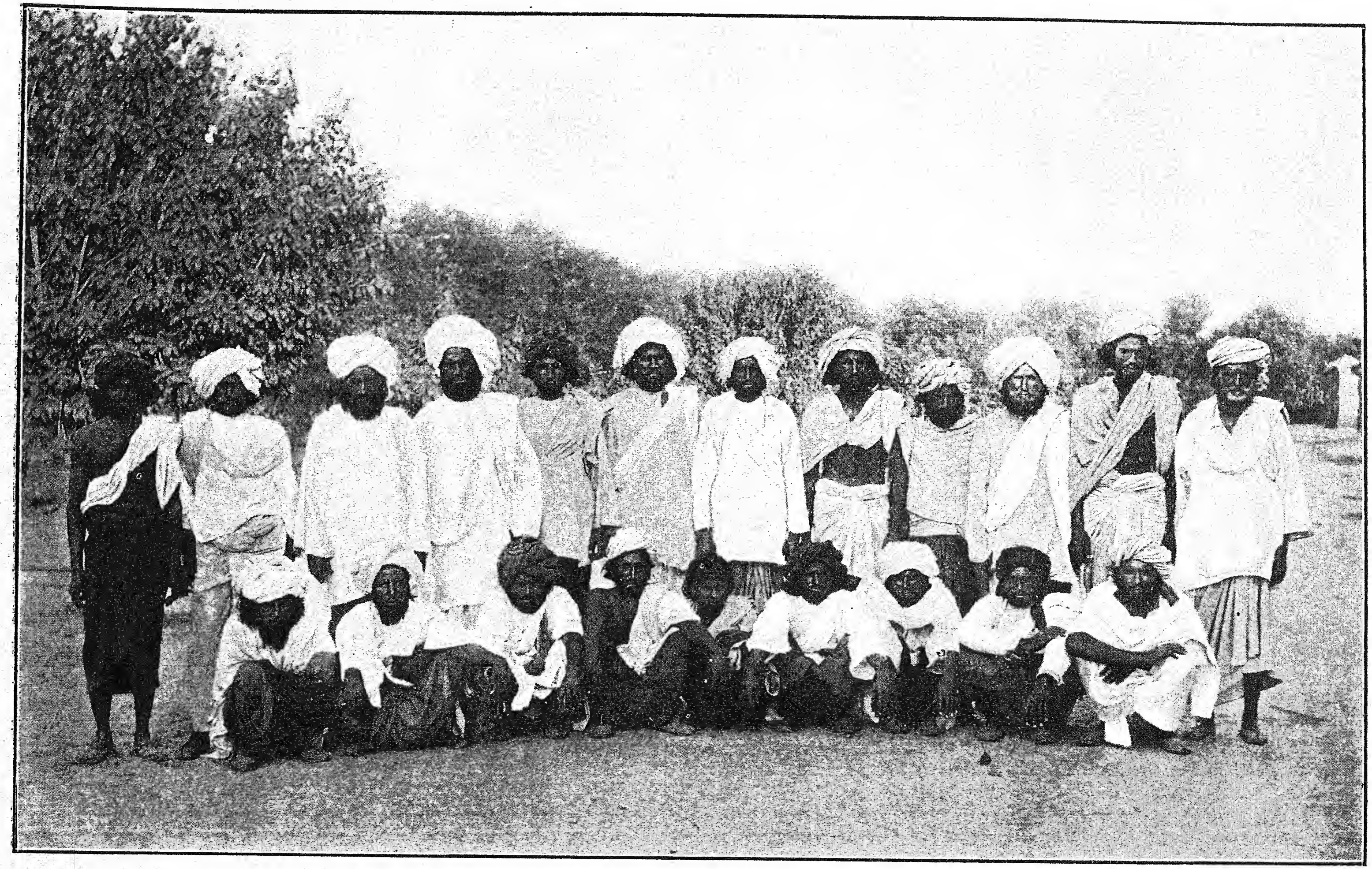
Mr. Hall concludes his paper as follows :—

"The net conclusions from the above experiments are that Calcium Cyanamide, as now manufactured, can be stored for a reasonable time under ordinary conditions without danger or sensible loss of its fertilizing properties ; Cyanamide can also be mixed without difficulty or loss with Superphosphate, the resulting mixture being as easily handled as any other artificial manure." —(A. G. Birt.)

UTILIZATION OF POND MUD.—("Journal of the Board of Agriculture," November, 1907.)

Pond mud is well recognized by practical men as being of great value where it is easily accessible. The analyses of different samples show it to be very little richer in plant food than good soil. Probably the good effect is due more to physical causes than actual manurial value. It has been found of great use for fruit trees and is much used in the Kew Botanical Gardens for this purpose.—(W. ROBERTS.)

PLATE XXVIII.



A. J. I.

THE BAR NOMADS.

THE CHENAB CANAL COLONY.

By G. F. de MONTMORENCY, C.S.,

Deputy Commissioner, Lyallpur.

Those anxious for information as to the origin and development of the present Chenab colony can find ample information in official volumes such as the Annual Chenab Colony Colonization Reports, the Annual Report of the Public Works Deptt., Irrigation Branch, and the Chenab Colony Gazetteer. In the present article it is not intended to tell the story of the formation of the permanent weir in the Chenab river, of the gradual allotment of nearly 1,900,000 acres of state desert lands to colonists, or of the formation of new railways and towns. It will be sufficient to dwell briefly on the material on which the colonist had to expend his labour and the class of colonist which was employed for the task of reclamation of the desert. Having disposed of these preliminaries, we can come to interesting points in the present methods of cultivation and crops of the Chenab canal colony.

2. *The Sandal Bar* from which the Chenab colony was framed, consisted of a vast rolling plain or upland lying between the Chenab and Ravi riverains. It was situated in the districts of Gujranwala, Lahore, Jhang, Montgomery and Multan. Its characteristic was its extreme flatness, with a gentle slope from the north-east to the south-west. At its highest point it is 670 feet above sea-level and at its lowest 489 feet. The surface of the plain was almost entirely unbroken. At Sangla there is a group of rock hills, an outlying isolated spur of the Aravalli range, and there are two old river beds of unknown antiquity which run through the Bar for many miles. On the borders of these, some old mounds with broken potsherds and bricks testified

to some past period of inhabitation and civilization. These were, however, the only accidents which relieved the intense monotony of the flatness of the plain. The tract was one of intense heat. In the interior of the Bar the rainfall in pre-colony days was seldom more than 4 inches and often much less. In the centre of the Bar the water level beneath the surface was 104 feet. The Botany of the Bar was not of a quality or variety which much relieved the intensity of the desert. The Bar was covered chiefly with three kinds of trees, growing mostly in clumps—the *Prosopis spicigera*, the *Salvadora oleoides* and the *Capparis aphylla*, locally called the Jhand, the Van and the Karil. An occasional Ber (*Zizyphus jujuba*) or Ukan (*Tamarix articulata*) relieved the sameness of the scene. Some variety was given by an occasional low bush of Malha (*Zizyphus nummularia*) or Phog (*Cabigonum polygenœides*). (Plate XXVII.) The jungle scrub varied in density towards the Ravi, and was in places too thick to force a horse through. In the southern part of the Bar the desolation and monotony increased ; the sandy loamy soil with its occasional patches of clay and ample, if monotonous, scrub gave way to pure sand and sandhills devoid of bushes and trees, and ornamented only with a few grey Salsolaceous plants, such as the *Haloxylon recurvum* and the *Suæda indiflora*. Trees here were so rare as to be known by distinctive local names and to be landmarks for miles in the desert. The Bar was the play-ground of the severest dust storms, rivalling those of the Rajputana desert. A dense dust haze often hung over the Bar for days together. Every tree and bush in the Bar with its stunted growth and gnarled, knotted limbs showed the fight which any living thing had to wage in that desert with a merciless sky. Small wonder that to the inhabitants of the rest of the Punjab, the Bar with its pathless, waterless expanse was a *terra incognita* of which everyone stood in dread. The Bar had, however, its kindlier moods and its own folk. The loam had here and there depressions with pockets of clay into which the water of the surrounding expanse would flow after scanty rains. These depressions held water for many months together. The soil of the Bar was

of such excellent quality and the accumulations of decayed leaves of the jungle scrub so vivifying that it needed but a slight shower of rain to restore to verdure the parched roots of the grasses with which the tract abounded. One shower and the Bar was transferred into a rolling plain of grasses—a thick mat of *Eleusine ægyptiaca*, *Sporobolus dientalis*, *Pennisetum cenchroides*, *Andropogon annulatus* locally called Chimbar, Kheo and Dhaman grass, spread itself out. Gathered round these ponds, the Bar nomad tribes used to pasture their cattle on these grasses, and in years of any rainfall the Bar was a paradise for those who had flocks and herds. Living almost entirely on milk and wild berries, they reared fine cattle and lived on the profits and sale of young stock, clarified butter, hides and horns. Years of great scarcity would drive them to the riverains : but the true nomad grazier lived in the Bar all the year round. After a bad season he replenished his flock by liberal thefts from surrounding districts. Against this expert tracker and thief, living in a patriarchally governed tribe in the middle of the desert, those who lost cattle had no remedy and no hope. No young "jungli", as the Bar nomads were called, could wear a puggaree till he had stolen some cattle successfully. The boy was brought up with cattle theft as his only career. If he delayed his first effort, his mother was ready to rebuke him with the jungli proverb : *Machhi sande pungre jamde tarand* (Fishes learn to swim as soon as they are hatched). Such was the Bar, a scene of extreme desolation and monotony. Those, however, who knew it in its pristine condition and know it now as the most successful agricultural paradise in the Punjab, must experience a pang of regret at the passing of a desert of peculiar natural fascination and the sudden transition from the life of the book of Genesis to the vulgar modernity of successful agricultural exploitation.

It was, however, the very monotony of the Bar plain, which made for its future success as a Canal colony. The level plain enabled the Irrigation Department to convey branches and major and minor distributaries without obstacle over an area which on the completion of the scheme will measure 6,073 square miles.

The greater portion of the Bar was *maira* soil or a sandy loam, especially easy of tillage and adapted to canal irrigation. The only poor soils which existed in the Bar were the *Kalarathi* or salt-impregnated and the *Retli* or sandy soil, both of which in the hands of good colonists improved greatly under irrigation. The flatness of the surface enabled the surveyist to lay out the whole of the Bar in squares of 1,100 feet square (about 28 acres), each of which was sub-divided into 25 sub-squares, each 220 feet by 220 feet (just over one acre). A country laid out like a chess board, one of the dreams of "Alice through the looking glass," became a fact instead of a freak of the imagination. These squares formed the basis of the system on which the allotment of land was made. The sub-squares each became a separate field for cultivation and irrigational purposes. Every cultivator who received a full square would map out his agricultural programme for the year and divide up his land to tenants in details of sub-squares and would be entitled to water to mature a fixed number of sub-squares per square.

3. *The Colonists.*—The Bar nomads scattered about the Bar, were the only inhabitants. At a rough computation they numbered 50,000 at the start of irrigation in 1892. (Plate XXVIII.) At the special census of the Chenab colony held in 1906, the population of the tract which had been the Sandal Bar numbered 8,57,829 souls. A few villages in the Bar were sold by public auction, but practically the whole of the land was given out to picked colonists. These colonists were of four kinds :—

(*a*) Capitalists with more than five squares of land each.

(*b*) Yeomen with three to five squares of land each.

(*c*) Peasant colonists with $\frac{1}{2}$, 1 or 2 squares of land each.

(*d*) Service grantees who held grants for the upkeep of camels or for breeding mules for transport purposes.

The capitalists were wealthy men or men who had rendered distinguished services to Government. The yeomen were usually men belonging to families of the more substantial squire or country gentleman class in the old districts. The

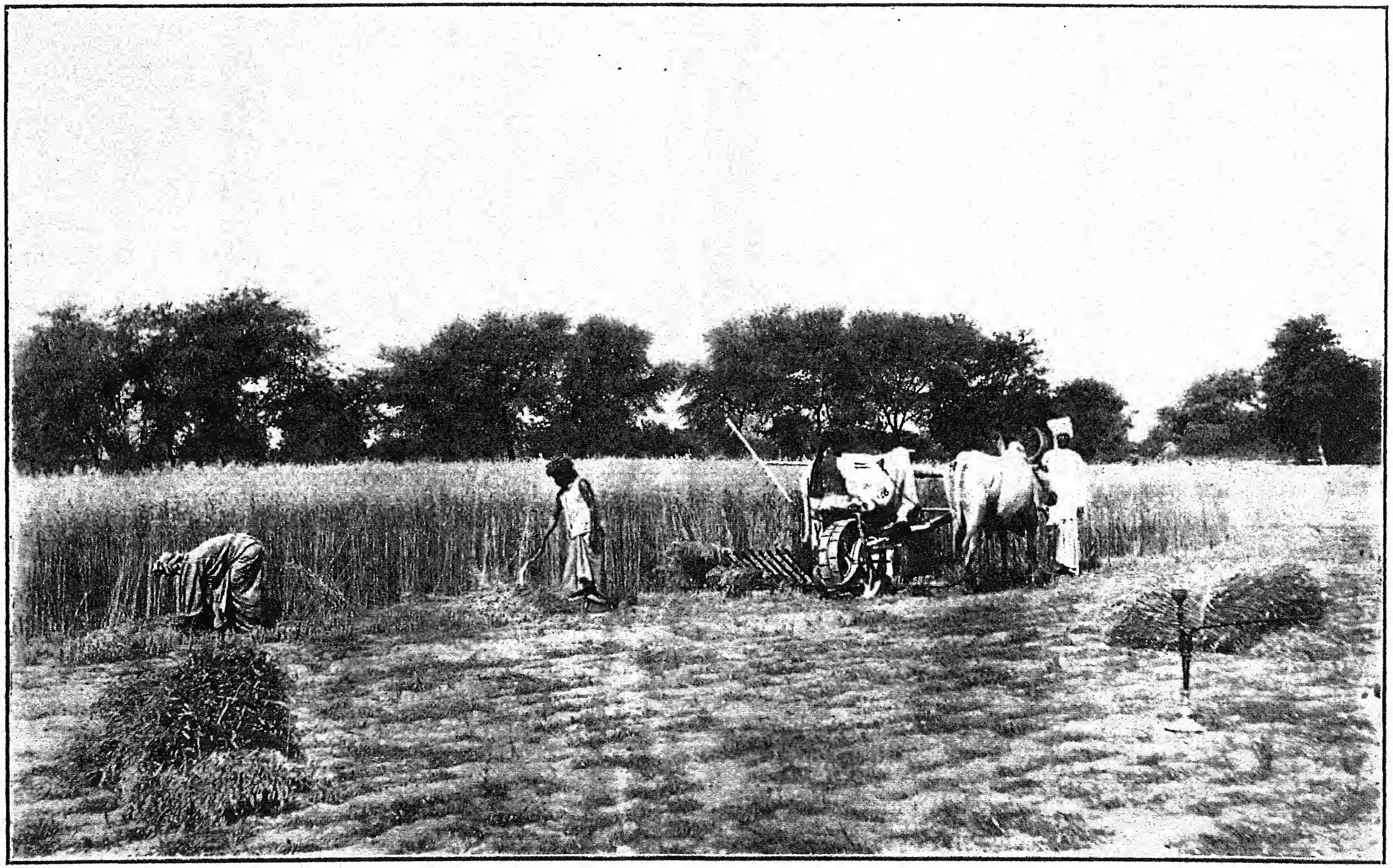
peasants were men picked from the ranks of the cultivators themselves in the more congested parts of the Punjab. They included in their ranks the nomad graziers of the Bar who had been dispossessed of their grazing grounds. The peasant colonists form the great bulk of the settlers and some account of their selection may be interesting. This can hardly be better described than in the words in which Mr. Grant, Settlement Officer of Amritsar, gave a description of his selections: "I used to find it convenient to halt a day at the village and the evening before to call up the headmen of the village to explain to them the terms on which land would be given. They were at the same time warned that any deceit or personation would be punished by my refusing to give any land to that village, and moving on to some other. They were told that they would be required to expose any deceit that might be attempted, and to name the men who were embarrassed by debt, and the bad characters. If, afterwards, it was found they failed to expose such, the whole list was liable to be cancelled. Then, they were sent to talk it over, until the next day, when all would-be settlers came up in a body. These I would first separate into *pattis*, and make the men of each *patti* sit in a long row, the fathers next their sons, and brothers next one another. Walking down the row, I could then easily see the men who were physically unsuitable. Many old dotards and mere boys would be brought up in the hope of thus securing an extra square for the family, though they had no intention of going and would do no good if they did. His colour would often betray the habitual opium-eater, and his general appearance (more specially his hands) the *shaukin* and the *jawan* who had been in the army or in Burma, and who, cutting his name after a few years spent with a regiment, had come home to the village, but had never done a hand's turn of honest work behind the plough. Such men would never do any good in the Bar. A show of hands is a simple method for discovering the real workers among the community. Next, if any one family was represented by too many members, one or two of these would be weeded out amid loud protests. Sometimes, the three

generations would come forward headed by a hoary old grandfather, and try to secure six or seven squares between them. It was plain that they would not all go, and even if they did, that their going would deprive some other family of relief, so they had to be thinned out. Then, with the patwari and the munshi at my elbow, and attended by the lambardar of the *patti*, I would go down the line and take down the names and the area of each man's share, his age, parentage, and *gôt*. This process would expose those who already had sufficient holdings or who had mortgaged a considerable share of their land, and these, too, were weeded out. The residue would be put down for a square each, with perhaps an extra square for the man who, by common consent, was named as the leading man of the *patti*—the bell-wether, whose lead all would follow. Thus, the original crowd of applicants would be reduced to a band of men all connected by common descent, all physically fit to take up a life in a new country under considerable difficulties, all hard up for land, but with sufficient resources to start them." *

The result of the selection was a great company of people with everything which makes for agricultural success. The capitalists and yeomen were drawn from all quarters. They had most of them seen the world, were above the average in intelligence, and had the leisure, money and acres to try agricultural experiments, new methods and new crops. The peasant colonists who received the bulk of the land had every kind of agricultural tradition and experience. There were the market gardeners of Amritsar and Jullundur. There were the sturdy Jat Sikhs of the Ferozepore and Ludhiana uplands who had grown rain crops all their lives. There were the enervated and careless cultivators of the riverains used to raising crops by hasty ploughings and sowings on rich alluvial deposits. There were the submontane cultivators of Hoshiarpur and Gurdaspur used to heavy rainfall and intensive agriculture in a congested country. There were

* Page 94, Colony Manual.

PLATE XXIX.



A. J. I.

Reaping Wheat, Lyallpur.

Amritsar and Lahore Jats with 13 or 14 years of experience of canal irrigation and cultivation on the Bari Doab Canal behind them. Lastly, there were the Bar nomads who had never held a plough in their hands or reaped an acre in their lives. There was plenty of variety in the elements. The jungli nomads had the whole lesson to learn, while the cultivators of various Punjab districts, who for years had known nothing but their own kinds of crops, their own agricultural implements and their own systems of tillage, could step into the next *chak* or colony village and see how their fellow farmers living at a distance of half the province away pursued the cult of Ceres.

4. *Crops and cultivation.*—The percentages of the chief classes of crops vary every year according to seasons and other special reasons, but roughly the chief percentages are—

Wheat	47	per cent.
Cotton	10	„
Toria	8	„
Maize	6	„
Millet	8	„
Sugar-cane	2	„

The remaining area is taken up with rabi and kharif fodders and miscellaneous garden, fibre, dye, and spice staples. The colonists brought with them two types of ploughs, the *Munna* or slant-handed plough of the Manjha part of the Punjab, and the *hal* or straight-handed plough of the Malwa tract. To this they soon added various kinds of iron ploughs from the "Kaisar-i-Hind" down to the latest American cold-steel light plough. In recent years at the Agricultural show a special new class has had to be started for ploughing competitions with iron ploughs.

Difficulties of labour and a heavy wheat crop have gradually taught the colony farmer to look for a more economical method of cutting down his wheat than the day labourer with his sickle. Manual delivery reaping machines of light draft have been introduced by various wealthy grantees, and it is anticipated that in a few years the village reaping machines jointly owned by an agricultural bank or a village of peasant grantees will become a regular institution. (Plate XXIX.)

Machines for making ridges, maize shellers and huskers and winnowing machines have also engaged the attention of the colonists Any firm, who were ready to exploit locally a really light and serviceable threshing and winnowing machine worked by bullock power, which could produce good *Bhusa* or pulverised straw, at the same time, would speedily make a fortune.

The stacking of bhusa is an interesting exposition of variety of method. The Sialkot grantee keeps his bhusa in a low heap which he plasters on the outside with mud. The grantees from the Amritsar part of the Punjab construct an elaborate thatched rick in the English fashion. The grantees who favoured the first method are gradually becoming converted to the second method as it wastes less of the surface bhusa and more effectually preserves the bhusa from attacks of white ants and rats. The first method has only one point left in its favour, that it is well nigh impossible for an enemy to set fire to the bhusa thus stored.

Wheat is the favourite colony crop. (Plate XXX.) There are five European exporting firms in Lyallpur who spend their whole time in buying and exporting colony wheat. A vast agglomeration of grain at a colony station or colony market in the wheat season after the harvest is a sight to see. There are a number of Lyallpur wheats which have been introduced by various colonists. The most popular of all is the *Lal Kasarwali Chitti*, a bearded wheat with a red ear and white grain. This has all the virtues ; it commands a good market price ; succeeds in most seasons, does not require too much water, has a strong straw and does not shell too quickly on maturity. It keeps well and is comparatively safe from weevils. Originally unknown to many colonists and in general use only by the colonists from the Central Punjab, it has now become the chief wheat for general growth and sale. Australian wheat No. 27, introduced by the Agricultural Department, is also growing in popularity. For personal use the colonists each grow a little *Goni* or a little *Vadhanak* wheat. The former is a beardless wheat with weak straw. It is much preyed on by birds and falls down if the winds are strong at the time of changing colour. It also shells rapidly on maturity. *Vadhanak*

PLATE XXX.

A. J. I. WHEAT ON THE LYALLPUR FARM.

is a heavy, tall wheat. It requires more water than any class of wheat in the colony and is much damaged by its weight if there are rains or winds at harvest time. The jungli and the riverain grantee thought one or two ploughings sufficient for wheat sowing. They are now, however, imitating their more experienced brethren and seldom plough land for wheat less than five times before sowing. Crop experiments in the colony show that the outturn of wheat for the past ten years has kept a very steady average. The more careful grantees sow with a drill, others drop seed behind the plough in a furrow and the most indifferent sow broad-cast. But even the broad-casted crop is generally sown very evenly and the seed-rate required for a full crop is much less than in Europe. The drill method of sowing is at present gaining ground as the best.

Cotton was an extraordinary crop on the virgin soil of the Bar when it first came under irrigation. On quite new land, with hardly any preparation, cotton in the colony used to produce 10 to 15 maunds to the acre commonly. After the first few years, however, the produce sunk down to 4 to 5 maunds per acre, an average which it maintains. Colonists brought with them several kinds of short-stapled cotton, and owing to the fine profits which they made from the crop, they were not slow in experimenting with new kinds. The best of the local kinds have proved to be the Hissar cotton and the red-flowered Multan cotton. Grantees select seed of these two cottons, and after a few harvests return to the parent districts for their seed to avoid the deterioration. Khaki-coloured cotton, Spence's cotton, American cotton, hybrid American and Egyptian and Assam cottons have been tried. The Assam cotton (the Garo hill variety) is doing well and seems similar in nature and requirements to the Hissar cotton on which it is an improvement. Egyptian cottons have been a failure. The bolls form too late and their complete expansion is checked by early frosts. American cotton has paid some of its devotees, but is undoubtedly more delicate than native varieties. Some colonists are persevering with Spence's tree cotton, but it has brought no lint to their mill as yet, and is alleged

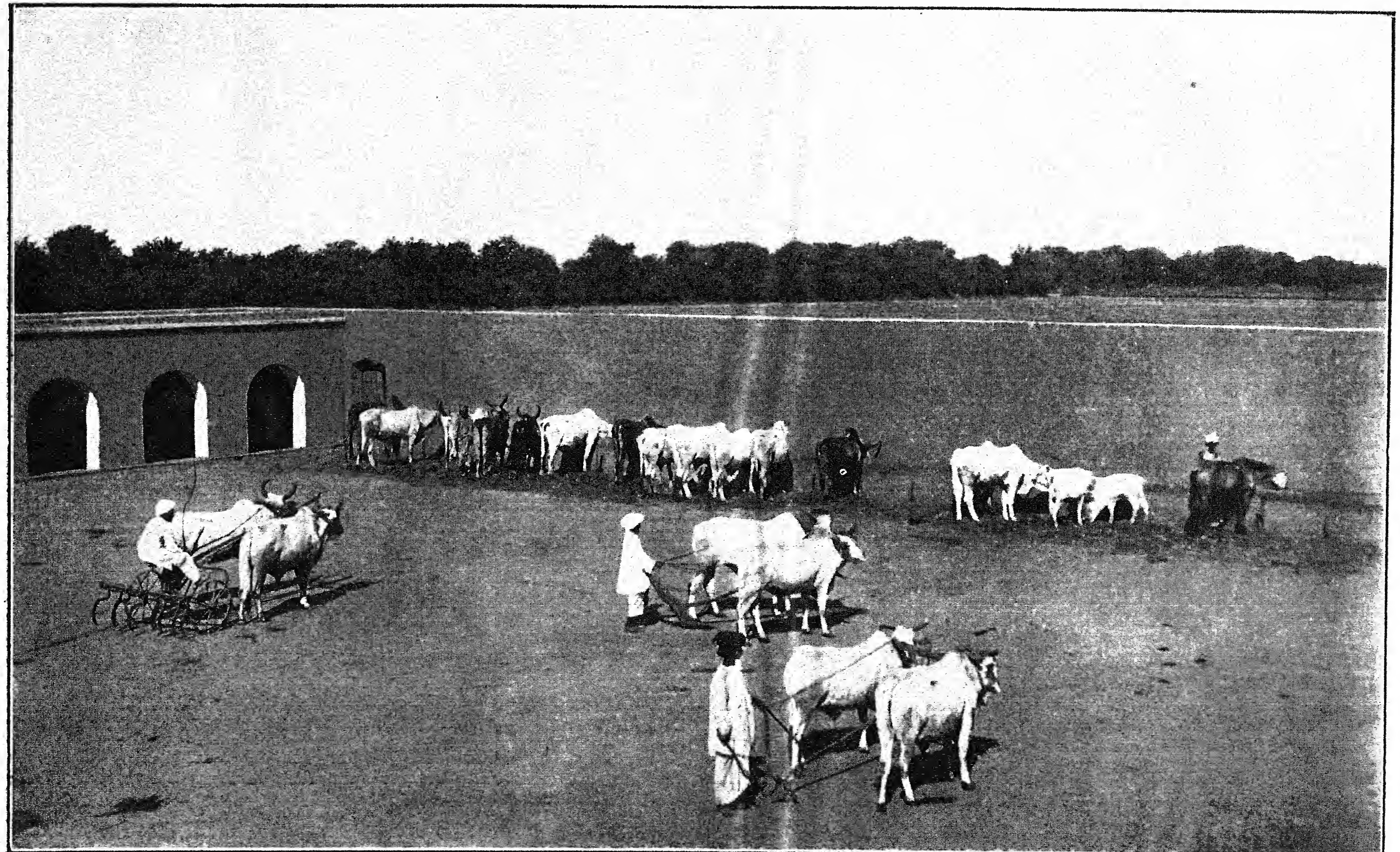
to act through the winter months as a hot-case for the preservation of all the pests to which cotton is heir and from which they issue as from Pandora's box in the spring when the new-sown cottons are coming up. Ridge cultivation is being tried. The colonist has already discovered that light plough hoeing between the rows of plants in *Sawan* (July), which has somewhat the effect of ridging, is worth three or four hand hoeings. Mr. Lefroy's boxes of parasitised bollworm are already a popular remedy against the depredations of the bollworm.

Toria (*Brassica napus*) is a curiously popular crop. The vast majority of grantees in their old homes sowed Sarshaff (*Brassica campestis*) and Taramira (*Eruca sativa*) only and had never heard of this kind of oilseed. On arriving here, they found their fellow colonists of one or two districts sowing Toria and were not slow to appreciate its merits. Its popularity is easily explicable; it is put down in September; it only occupies the land for $3\frac{1}{2}$ months. It requires no attention after sowing; it takes very little water, and that mostly at a time when wheat sowings have not commenced. It is reaped when wheat sowings are finished and the rush of cotton-picking is at an end. It is readily bought at good prices for export to Europe, where it is turned into "fine Lucca oil." Some seasons the cultivator is repaid by 12 maunds to the acre, for which he can get Rs. 5 per maund. It is liable to attacks of green fly and to be dried up by hot winds. Some grantees have tried spraying for the green fly when it first makes its appearance with success.

Maize and millets grown in the kharif season are the chief food-grain crops of the people. They freely enter into rotation with wheat, oilseeds and cotton. Their cultivation serves with advantage to distribute the labour of agriculture more evenly throughout the year. The extending cultivation of sugarcane on many holdings of small individual areas is a marked sign of material agricultural progress. Iron roller sugar mills are in common use and a good deal of capital per acre is invested in this crop.

The miscellaneous crops are interesting. The Amritsar *Kambohs* who are the best cultivators amongst the colonists

PLATE XXXI.



A. J. I.

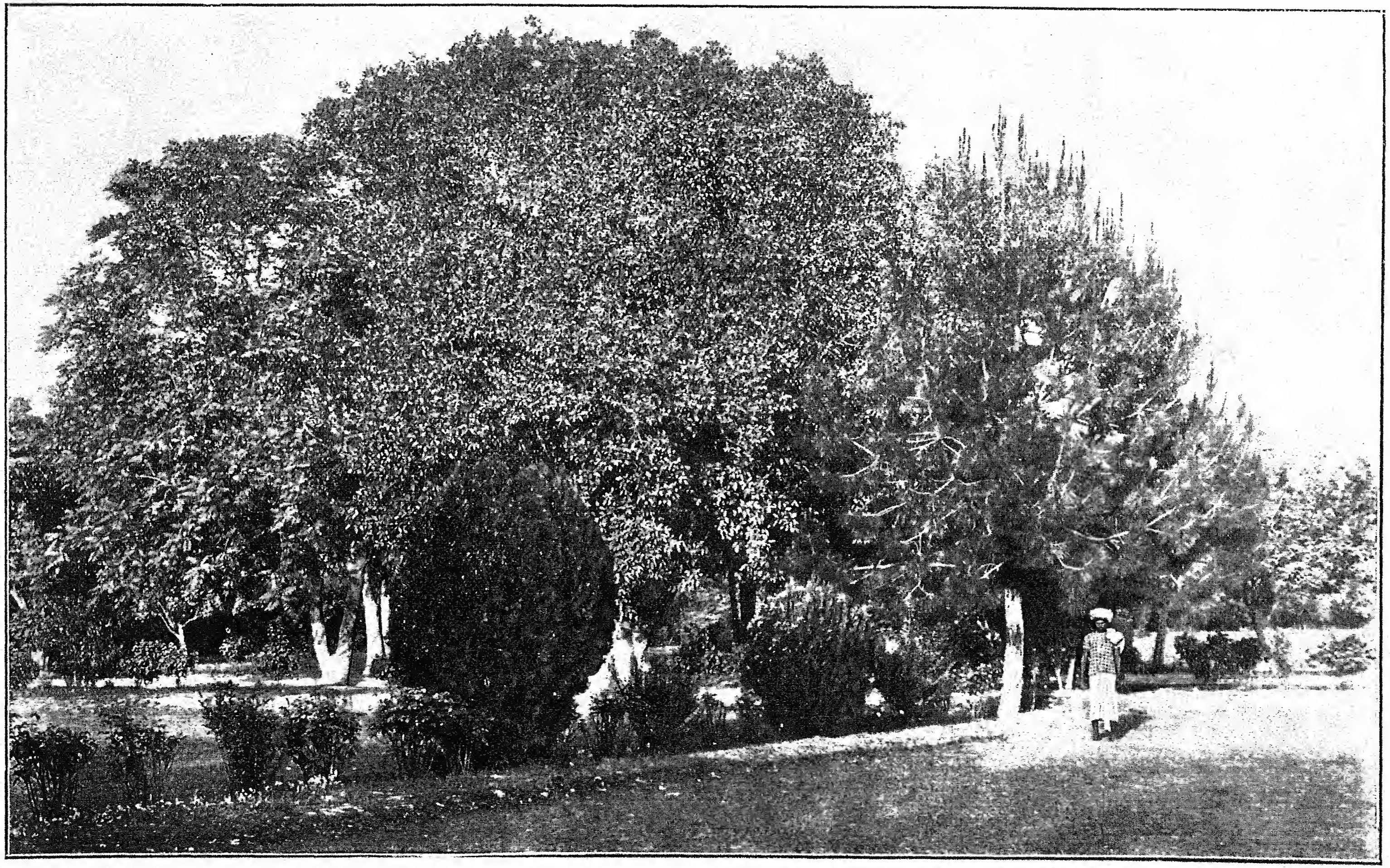
WORK CATTLE IN THE LYALLPUR FARM.

habitually grow one or two sub-squares of potatoes and roses. They have had many imitators in growing potatoes, but no one else has as yet followed in their wake in growing roses for *atar* of rose manufacture. Other grantees are experimenting with jute and linseed grown for fibre. The retting difficulty has yet to be overcome, though, as far as produce goes, they have nothing to regret in their efforts. One grantee has been most successful in the cultivation of turmeric on a large scale: this has been previously popularly supposed to be only successful as a submontane crop in the Punjab. *Sardas* (or the Kabuli melon) have been grown by a number of colonists with success when the Peshawar colonists had once shown the way. The Amritsar and Jullundur colonists introduced lucern as a common fodder crop, and now, even in the squares of the Bar nomads, patches of this useful fodder and of *Sengi* may be seen. Turnips are extensively and successfully grown as cattle food. The Chenab colonist always has his eye open for something new, whether it be a staple, an agricultural implement or a new method. An amusing incident illustrating this occurred recently. One of the most successful of the Mohamedan immigrant colonists decided to give up his worldly possessions to his son and to go on a pilgrimage to Mecca and return to live a life of spiritual introspection. His estates knew him no more for a year. At the end of the period he returned somewhat austere of appearance and reserved in conversation. A little less than a week after his return, however, he made it known that the interest of the pilgrimage had not entirely subjugated the Chenab colonist's desire for some new thing in agriculture. He had brought from the sacred place 20 different kinds of Arabian dates, one tree cotton and six kinds of Sinaitic vegetables. He has put them down and they are nearly all doing well. Many orchards have been started in the colony and orange growing promises very well. It is a curious fact that the mango is an utter failure in the colony.

The Chenab colonist has the acres and the opportunities afforded by perennial irrigation of perfecting the kind of staples

which he adopts and the method and implements for their improvement. As a body, they include some of the most experienced and skilful farmers of the Punjab. The fact that in the keen competition at the agricultural shows at Lyallpur the Bar nomad has been able to wrest the first prizes for cotton, wheat and maize from hereditary experts, is a proof that even the most ignorant of the body of the colonists is determined to keep his eyes open and see what the best methods and seed-selection can do for him. This tends to show that the Chenab colony will not only be known in its young days as a vast field for the production of cereals, cottons and oilseeds, but that skill and science will come to aid nature when the virgin soil begins to lose the first bloom of its virtues and that the tale of productiveness and prosperity will suffer no diminution.

PLATE XXXII.



A. J. I. EIGHT YEARS' GROWTH OF TREES IN LYALLPUR.

THE FOURTH ANNUAL MEETING OF THE BOARD OF AGRICULTURE.

By. E. J. BUTLER, M.B., F.L.S.,

Secretary to the Board.

The fourth meeting of the Board of Agriculture was held at Pusa from the 17th to the 22nd February 1908, under the presidency of Mr. J. Mollison, Inspector-General of Agriculture in India. It was attended by fifty-one members and seven visitors, an increase over even the large attendance of last year. These numbers were made up of the members of the Imperial Department of Agriculture; the Directors of Agriculture of each province except Bombay and several members of the expert agricultural staff of each; representatives of three Native States' Departments (Mysore, Baroda and Kashmir); the Director-General of Commercial Intelligence (Mr. Noël-Paton); the Director of the Botanical Survey (Capt. Gage); the Reporter on Economic Products (Mr. Burkill); and the Scientific Officer to the Indian Tea Association (Mr. Hutchinson).

The subjects for discussion were varied. Besides a consideration of the programmes of the different Agricultural Departments, they included practical questions such as the best means of bringing the work of the Departments home to cultivators, the extension of fibre cultivation in India and poultry breeding; educational questions such as the best course of studies at Pusa and at Provincial Agricultural Colleges; and administrative matters such as the constitution of the Board of Agriculture, the form of its Report, and the staff required in certain sections of Provincial Departments, with the rates of pay necessary to secure good men for the upper subordinate posts.

In the programme of the Imperial Department of Agriculture it was pointed out that the scientific staff of the Pusa Institute will be for the first time complete, and will consist of fourteen European officers, with a full complement of Indian assistants. The Institute laboratories will be finished and occupied this year, affording much needed relief to the staff, who have been working up to date in ill-equipped temporary buildings. The farm is now practically all under cultivation or pasture, and it has become possible to commence permanent field experiments on land whose capacities are fairly well known. Three considerable series of manurial, rotation and pasture experiments were approved by the Board and have been commenced.

Besides these permanent experiments, which are regarded as being of the first importance, the work of the Agricultural section at Pusa proposed for the current year includes experiments with important crops, such as sugar-cane, flax and other fibre crops, tobacco, wheat, rice, maize, opium and castor, and cattle, sheep and poultry breeding.

In the Chemical section the chief subjects under investigation are the available plant food in soils; the nature and amount of substances which are removed by drainage; the factors controlling the movements of soil water; the amount of water required by various crops; and chemical investigation connected with the permanent field experiments at Pusa.

In Mycology the study of a number of crop diseases will be continued and new ones taken up. As this section, in common with that of Entomology, is intended to deal with work in all parts of India (there being no expert mycologists or entomologists on the staffs of Provincial Departments), a considerable amount of time is taken up with tours for the investigation of crop diseases. The preparation of a text-book on Indian Agricultural Mycology is in hand.

In Entomology, besides continuing the work of studying and advising on crop pests, the experimental cultivation of lac and of eri silk will be continued, and other wild silks taken

up. Other enquiries include the investigation of insecticides non-poisonous to cattle, the study of insect-eating birds and methods of checking pests of stored produce. Tours to investigate local pests or to deal with outbreaks of injurious insects will be undertaken. The second Entomologist will be engaged in the study of biting flies and of dipterous pests of crops. It is hoped to bring out a book on Indian insects during the year.

In Economic Botany, work on plant breeding and plant improvement will be continued with wheat, tobacco, cotton and barley, as well as other important rabi and kharif crops. A monograph on Indian wheat will be completed. The permanent experiments on the culture of Indian fruits will be continued, and also the collection and investigation of fibre-yielding plants. Other work includes the study of Cassava as a famine food-stuff (with the Imperial Agricultural Chemist), and the economic importance of the male plant in *ganja* cultivation.

In Provincial Departments the main lines of work in progress were referred to briefly in the account of the Third Meeting of the Board of Agriculture published in this Journal last year. * Nearly all are adding to their existing experimental farms or getting those recently taken up under cultivation. Several of the new stations are intended for special work, such as those at Partabgarh in the United Provinces for sugar-cane, at Daulatpur in Sind for alkali reclamation, at Chaibassa in Bengal for Tassar silk, and at Burirhat in Eastern Bengal for tobacoo. Most of the older farms are engaged in more general work, as described in the review of last year's meeting, and an account of their work, and of the very varied activities of Provincial Departments, would take us far beyond the limits of the present note.

One of the chief functions of the Board is the detailed examination of these programmes with a view to suggesting improvements from the combined experience of agricultural officers in different Provinces, to prevent overlapping and to secure co-ordination where this is necessary. It was felt that

* *Agricultural Journal of India*, Vol. II, p. 224, July, 1907.

this function is not easily fulfilled by the full Board, and a recommendation was made, which will probably be followed in at least the alternate years when the meetings are held at Pusa, that the programmes should be submitted to expert sub-committees before being presented to the Board.

The constitution of the Board itself came under discussion in response to a reference from the Government of India. The number of members has grown year by year until it has reached unwieldy proportions. It was recommended that the number be curtailed to 38, made up of 11 Imperial and 27 Provincial and non-official members, six of whom should be nominated each year by the President, and four elected by the provincial expert staff. In addition, it is hoped that, in alternate years, when the Board meets at Pusa, all members of the Agricultural Departments in India (including Native States with such departments) will attend, where possible, as visitors, though not as official members.

The improvement of Indian poultry has been consistently advocated for years by Mr. H. Abbott, Editor of the "Indian Fowl Fanciers' and Farmers' Journal." Largely as a result of his efforts, the subject was included amongst those set down for discussion at the recent meeting, and he was invited to attend. Some remarkable figures were provided of the development of poultry-farming in the United States in recent years. By the census of 1900 the number of birds on the farms from which returns were secured was over 250,000,000, and the year's produce in birds and eggs amounted in value to more than £56,000,000, probably exceeding any single item of the farm produce of the United States. The Indian *moorghi* is notoriously degenerate, and the supply besides is by no means equal to the demand, with a resulting steady rise in price. To improve the industry Mr. Abbott holds that Government assistance, both in advice and in provision of improved breeds, should be given to native professional poultry breeders. In addition, a strong effort should be made to extend poultry-breeding through all useful agencies in India, such as agricultural

experiment stations, grass farms, missions, European planters, Eurasians and well-to-do Parsees and Mohamedans. While endorsing much of what Mr. Abbott said, the Board considered that the results of the preliminary work now being carried on at Pusa should be awaited before any large attempt to extend the industry through Government agency was entered on. Should these experiments show that the breeding of improved poultry gives promise of becoming a remunerative industry, the Board recommended that the work should be extended through the above-mentioned agencies, and indicated generally the varieties likely to prove most suitable for breeding purposes, and some of the important points requiring attention in the care of poultry in India.

The effect of the extended cultivation in India of fibre plants other than cotton and jute on the material prosperity of the country and the best lines for future experimental work in this direction were discussed by a sub-committee. Their report indicated that the time allotted for its consideration was inadequate for so large a matter. It was decided to collect whatever information was available in each Province, and the President, together with the members of the sub-committee, were asked to arrange for the publication of a consolidated report in pamphlet form.

As the educational side of the work of Agricultural Departments in India will soon be fully organised, and there will shortly be available seven Agricultural Colleges in the Provinces, besides the college for higher instruction at Pusa, the courses of instruction to be provided at these colleges were again considered. In 1906 the Board provided a draft syllabus for Agricultural Colleges. This was now revised in certain details in the light of the experience gained by officers of the Department during the intervening period, and arrangements made to print it separately for distribution to those concerned. It is intended to serve as a basis on which Provincial Colleges will be able to arrange their courses of instruction, but it was recognised that a moderate amount of expansion or reduction may be necessary in individual cases to suit local requirements.

The greater part of the discussion ranged about the degree to which practical training might precede theoretical instruction. On the one hand, it was held that since the majority of the students will be deficient in regard to a general education sufficient to enable them to understand readily the principles of good agricultural practice, it should be recognised that the courses will fall into two groups :—(1) subjects taught for their educational value ; (2) special subjects directly connected with agriculture. Since agriculture may be regarded as an art based on several sciences, the subjects under the 1st group are taken to be the sciences on which the art of agriculture is founded ; and it is contended that these subjects should be taught in such a way that the main object of a sound education may be achieved. These subjects are Chemistry, Physics, Botany, Zoology, and Mathematics. It was held by several members that no sound teaching can be given in the second class of subjects until at least a good basis is laid in the first. Hence, in the first year only these subjects should be taught, and in the second year special agricultural training may be commenced.

Opposed to this was the opinion of the majority of the Board, that practical training in the field should be undertaken at the very start. The arguments in favour of this view were almost entirely of a practical nature, with particular regard to the character of the students who would attend Indian Agricultural Colleges. Many of these are disinclined by upbringing and tradition to themselves actually handle field implements. These are amongst the better class students whom it is hoped to attract for training to fit them for managing their own estates or to become managers of other estates or assistants in Agricultural Departments. It is recognised by all that sound agricultural training is impossible, unless the actual processes of agriculture are carried out by the individual student for himself; the introduction of practical field work at the start impresses this on the student's mind and serves to weed out those who will not, for this reason, profit by their training. A further reason for commencing practical work at the earliest opportunity is the leaning of the Indian

mind towards the abstract rather than the concrete ; it is feared that theoretical instruction, too exclusively followed at the beginning, may deflect the attention from the end of the training, which is to improve agricultural practice, and may lead to a neglect of the art in the study of the science of agriculture.

With regard to the class of instruction to be provided at Pusa, it is recommended that this should consist of post-graduate courses for students who have already passed through a Provincial Agricultural College, and for other selected students who, by reason of their education in science, are likely to derive real value from the advanced courses. These courses should, it is suggested, be provided for the following :—(1) students intended to become assistants to provincial experts in Agriculture, Agricultural Chemistry, and in particular Economic Botany, Mycology and Entomology ; (2) students sent for special purposes. Courses of instruction on these lines will be prepared at Pusa and submitted at the next meeting of the Board for approval.

A prolonged discussion took place on the rates of pay and prospects required to attract the right class of men to the subordinate staff of Agricultural Departments. The more senior members of the Board were practically unanimous in holding that the present prospects were insufficient to attract good men. The suggested rates, however, differed in the different Provinces, though the majority held that the Provincial Executive or Revenue service should serve as a standard. The Board finally suggested that the prospects for the upper subordinate staff should be made somewhat better than those of the Provincial Executive Service, in view of the fact that the service is new and specialised, but was not in a position to suggest the number of posts or particular grading required in each Province.

In connection with the recruitment and training of the requisite Indian staff, a discussion took place on the lines on which mycological and entomological work in the Provinces should be conducted. In these subjects no European specialists are engaged outside Pusa. It was recognised that the research

work should be done as far as possible at Pusa, and that Provincial work in Mycology and Entomology should be limited to the employment of a special staff (1) to give such assistance to Pusa as is required for this work and (2) for the elementary training required at Colleges. The practical field work for the prevention of pests and diseases should be undertaken by the ordinary staff of agricultural assistants. The Provincial Economic Botanist should control the mycological teaching at Provincial Colleges.

Probably the most important subject considered at the meeting was that of the best methods of bringing the work of the Departments to the notice of cultivators. In India the attempt is being made to influence the mass of the people and to bring about a gradual improvement in the industry by which the majority subsist, by working from the top downwards. It is self-evident that this attempt will succeed or fail according as the Department of Agriculture wins or fails to win the confidence of the cultivators. Could the country afford to await the spread of primary education, the work of the Department in this direction would be much lightened; this is for many reasons impossible, and the departmental officers have to face the fact that they must deal with a class whose needs are often obscure or inarticulate, who are prone to distrust official interference, who are shy of the European and whose conservatism, though sometimes exaggerated, is very often a decided bar to suggested improvements.

It has been recommended that year by year an account should be furnished to the Board of Agriculture of the efforts of the Departments in the different Provinces to reach the cultivators, and of their results. The first of these reports was drawn up at the recent meeting, and, besides being included in the Proceedings, will be separately published for general information. It deals in succession with the methods employed or suggested by the several Departments, premising that each is adapted to special conditions. The following are amongst the chief of those dealt with :—

Agricultural Associations.—The formation of local associations for agricultural improvements has been one of the most common methods of increasing interest in the work. There has been a good deal of discussion as to the value of these associations, and so far it may be said that no two Provinces have had quite similar experiences with them. This seems to have resulted chiefly from two causes : first, the personal touch maintained by the officers of the Agricultural Department and the prominent members of the Association with the cultivators ; second, the extent to which the Department has as yet had real improvements of proved value available for introduction. The closest personal touch can be maintained in small associations, such as village or taluka associations, but for this a considerable number of trained officers of the Agricultural Department is required, and these are not yet available to any large extent, nor is there probably sufficient confidence in the Department to make them a success. Hence the future of the small associations is bound up with the Agricultural Colleges, and it is not until these have turned out a large number of reliable trained assistants and inspectors that any great development in this direction can be attempted.

In some Provinces, District Associations with the Collector as Chairman have been successful. As the number of these is limited, the superior officers of the Department are able to attend the meetings (held half-yearly in the Central Provinces). The utility of these depends largely on the presence of a body of substantial men who are also cultivators, and on the engagement by these to carry out definite pieces of demonstrational work proved by the Department itself as likely to succeed.

It is in the provision of definite demonstrations of proved value that the second difficulty is likely to arise at the present time. So many variable factors arise in agricultural practice that progress must necessarily be slow and the departments are still very young. The introduction of a new crop or variety, or of a manurial practice, though fully tested at an experimental farm, may fail, unless the farm is exactly representative of the tract.

The cost has to be very carefully calculated or a new method may be beyond the reach of the small cultivator. Errors in the management of the demonstration are only too likely to occur. In India, agricultural change must usually follow economic change, not lead it. The extended cultivation of poor hill soils which will grow tapioca was brought about in Travancore by the rise in the price of grain, driving the poorer classes to find a substitute; without this incentive it would probably never have occurred. Similar cases could be multiplied, and it behoves the Departments to be ready to meet a demand as soon as it arises, as well as to endeavour to create a demand for new improvements.

Speaking broadly, then, the two things on which the success of Agricultural Associations in bringing about direct improvement depends, would appear to be confidence in the advisers, leading to their advice being carefully followed, and the provision only of carefully considered and tested improvements for demonstration, with arrangement for efficient management. Failure to secure these may, most likely will, result in failure of the demonstration; the confidence of the small cultivator will be shaken, and the result, with a distrustful and sceptical community, will be deplorable.

Demonstration Farms.—Similar to the demonstration work of the Agricultural Associations, only more directly under Departmental control, is the work of these farms. They have not yet been developed largely, except in the Central Provinces, but if the above-mentioned dangers are avoided, they appear to give considerable promise of success. With the associations they are bound to take a prominent place in any arrangements for the provision of good seed. This work is at present carried out by a limited number of seed farms, or by seed depôts, such as those described in this Journal, Vol. II, p. 217, in Oudh; it cannot be doubted that, in the absence of professional seedsmen comparable with those of Europe and the United States, a large development of Government work in this direction is inevitable. With such a development the utility of the demonstration farms will be multiplied.

Village Agencies.—These are employed chiefly for the purpose of introducing improved implements. The agent controls the sale or hire of implements received through the Department. Repairs are arranged for by periodical visits from workmen of the Department.

Publication of Agricultural information in the Vernacular.—Several vernacular agricultural Journals are published by or under the patronage of the Departments. In the Central Provinces the monthly departmental paper has a circulation of 2,500. Better results are thought to be obtained by encouraging and contributing to privately owned vernacular agricultural Journals. For the higher English-speaking strata, the *Agricultural Journal of India* should be sufficient to meet requirements and the Provincial Departments should aim at reaching cultivators and landowners through vernacular journals. Many of the Provinces issue agricultural leaflets, which usually deal only with one definite fact, or the description of a single process which it is desirable that the ryot should know or adopt. It is too early yet to judge whether these have been generally successful, but they have been useful in certain cases. Contributions are made to the general vernacular press in certain Provinces with good results.

Agricultural Shows and Exhibitions.—These have been started in nearly every Province. The exhibits are arranged by the Department, one of the members of which attends to lecture on them and arrange practical demonstrations. In some cases advantage is taken of locally arranged non-official exhibitions, and in Bombay, parties of cultivators have been taken to these and the exhibits demonstrated to them. Cattle Shows in some localities have proved a considerable success; the Department gives prizes and organises the show. Local festivals and meetings for the grant of *takavi* advances have been made use of in some cases to demonstrate new implements and other improvements.

Itinerant Assistants.—In most Provinces travelling assistants have been employed for such purposes as the introduction of new varieties of seed and new implements and for advising with

regard to the treatment of special crops, as for instance, in manuring sugar-cane and in pointing out the dangers of over-irrigation with this crop on the Deccan Canals. In the same connection may be mentioned the travelling staff of trained well-borers maintained in the United Provinces. Their operations have been of the greatest value in inclining the people to rely on the assistance of the Department in agricultural matters generally.

Work directly with Cultivators.—In a few cases great improvement in local practice has been obtained by the introduction of cultivators from one district to another. The method is likely to be most useful where a new crop has been introduced into a district, and it is probably capable of extension in such cases.

Short courses for cultivators have been given on the Bombay farms in special matters, such as cotton seed selection. The sons of cultivators are also taken for instruction on these farms. This method is believed to be worthy of more extended trial if cultivators can be induced to go to the farms for the purpose.

In all these methods the aim is to show the actual cultivator some improvement he did not know before and which is within his means. As he is not a capitalist, he cannot usually afford to gamble, but must have a certainty. His cultivation expenses are usually met from borrowed capital and the rates of interest he has to pay are exorbitant. Hence the question of agricultural improvement is closely bound up with the provision of cheap credit, and there must be intimate connection between the Agricultural Department and the co-operative credit organization, which is being developed so extensively.

Apart from all questions of organization, the ultimate work of the Departments is to discover improvements. If any really good improvement can be presented to the Indian agriculturist, he is ready to take it up. That he has not adopted many practices that to the Western eye would seem to be improvements, is often because they are not suited to his own or to India's special conditions, and that would-be reformers have simply been without sufficient knowledge of these. Western ideas and Western

methods cannot be introduced off-hand into India. Much of its agricultural problems have to be worked out on the spot, and there is abundant evidence that these problems are engaging the energies of the Agricultural staff in India in a much more thorough way than ever before. Some of the many directions in which improvements may be looked for were enumerated in the account of the 3rd meeting of the Board referred to above. As these come to fruition, the organization to secure their adoption by the mass of the cultivators will be severely taxed, but I think that the outline just given will indicate that it is likely to prove equal to the demand.

A FEW POINTS REGARDING CONSERVATION OF SOIL MOISTURE.

By D. MILNE, M.A., B.SC.,

Economic Botanist, Punjab.

In India where there are large tracts of country where crops are often limited in growth by the supply of water available in the soil, any improvement in the conservation of the soil moisture would be a boon worth striving for.

One has only to travel a short distance at present to see, in the great expanse of bare land and poor crops, the sad havoc wrought by drought.

To avoid these utter failures of crops by means of careful cultural operations, the farmer can often do little, but there are cases where the alert farmer might, by skilful farming, reap a very much better crop than his more backward and careless brother.

Some farmers have told me that on their land, at present totally barren, if they could only have got their wheat to "braird," *i.e.*, germinate and spring above ground, the crop would have come to something. Whether or not any good can be done in such extreme cases is hard to say, but certainly there are lands where a study of the conservation of moisture might be well repaid.

It is not my purpose in the present note to go very scientifically into the above subject, but rather to point out or remind the tillers of the soil, of a few facts, and to quicken, if possible, the interest of those whose business or hobby it is to properly investigate the matter.

First, then, it is a well-known fact that a soil on which plants are growing loses much more water by evaporation than does a bare soil.

Some plants with a root system ramifying through a fairly large area, to various depths in the soil, and possessing also a considerable extent of leaf surface for the dry winds to play over, may evaporate a very large quantity of water, indeed, in 24 hours.

I have no Indian figures at hand, but for Europe we find several.

In Pfeffer's Physiology, Vol. I, pages 250 to 251, we find recorded: "Hales found that a sunflower having a total area of leaf surface of about 9 sq. m. ($10\frac{2}{3}$ sq. yards) lost 0·85 kilogrammes (1 pint) of water during a single dry day." "Haberlandt found that oat-plants covering one hectare transpired 2,277,760 kgs. during a single vegetative period, while barley plants covering a similar area exhaled 1,236,710 kgs. of water." This means that an acre of oats evaporated nearly 900 tons of water, and barley well on to 500 tons during their respective periods of growth.

Whatever accuracy these men may claim for their figures in their own conditions, my point is, that although plants may differ in the relative amounts of water transpired from them during a given time and in various conditions, it is a well-known fact that all plants do transpire a very considerable amount of water during the 24 hours.

It is evident, then, that from the point of view of the farmer cultivating lands in a droughty country, the lands should be kept clear of weeds.

Again, it is well known that on bare land which is fairly firmly consolidated right to the surface, more moisture will eventually be lost by evaporation than on land the surface of which has been well pulverised and kept stirred to the depth of a few inches.

One might very roughly explain this by saying that the water rising up the walls of the minute openings between the soil particles can, in the case of the compacted soil, rise right to the point where it can be quickly evaporated by coming directly in contact with the dry winds sweeping over the surface of the land.

As the moisture at the surface is evaporated, more is induced to take its place, and as it must come from below, we have a comparatively rapid current of water being brought upwards and lost by evaporation.

In the case of the soil of good tilth, the surface, few inches of which are stirred up loosely, the openings between the particles are too coarse to allow the moisture to rise freely in these few inches. Also in the large interspaces between these particles a considerable volume of air is trapped and forms a semi-damp, more or less stationary protective cushion of air between the quickly changing dry atmosphere above, and the point to which the water is comparatively easily brought up.

Whatever the real theoretical explanation may be, however, the point of practical importance is, that a soil, the surface few inches of which is well pulverised and stirred, does conserve the moisture much better than a more compact one, and that farmers who wish to retain the moisture in any particular area of land, should not simply plough the soil and leave it in large rough lumps, and great openings between the furrows, but should pulverise and stir the surface by harrows or other suitable means.

This pulverising of the surface should be done the same day as the land is ploughed on all soils, but especially on stiff clays, not only because of the saving in moisture effected, but also because of the greater ease with which the lumps can be broken.

Treated promptly in this way, a fine tilth may be got cheaply and with ease even on stiff lands where no amount of work can procure a good tilth if the lumps are allowed first to get dry.

A third way of conserving moisture is often practised in various parts of the world. It is called "mulching."

Some fairly open or porous material such as refuse litter, inferior grass, or inferior straw, leaves, or other organic substance, is spread in a thin layer over the surface of the land; the idea being to form a layer of matter which will retain a considerable volume of air in the spaces between its component

particles, and so retard the swift exchange of the dry air of the atmosphere for the more or less moist air that is in contact with the soil surface. Mulching therefore has underlying it the same idea as the stirring and pulverising of the upper few inches of the soil.

Unfortunately, mulching, though very useful, is difficult to carry out on large areas. In some parts of India, however, I believe it is a common practice for special crops, such as tea, coffee, and some market garden crops.

The implements used in tillage operations here appear to me of considerable interest in relation to conservation of soil moisture, and I think a study of these from this point of view might give some results worth having.

Take, for example, the ordinary native plough and compare it with the common English or American ploughs.

The native implement differs essentially from the other two quoted, in the fact that while the others partly or completely invert the soil, the native one stirs but does not invert it.

The difference appears to me to hold in it a question of considerable interest, for if a slight mulch causes a material reduction of the amount of water evaporated from the soil, then, may there not be a material difference in the amount of water evaporated from a soil ploughed by an English plough and one ploughed by the native implement?

In the one case the organic matter of the previous crop residue would be more or less deeply buried, and in the other practically left on the surface to act as a mulch.

With years of tilling with the native plough, and the consequent accumulation of organic matter on the soil surface, which might be expected up to a certain point, the beneficial mulching effect might also be expected.

I should like to hear of some farmer using the native and an American or English plough on two separate areas, under similar conditions, over a number of years, and noting the practical effect on his crops, and if he or some one interested would like to go further into the matter and had the necessary skill and

apparatus, a set of borings of these lands could be taken and the amounts of moisture in them ascertained and compared at intervals.

The borings might be taken at different depths; regular intervals of time; of cropped and uncropped areas; and other points may require attention.

The above, however, are mere suggestions.

Besides conservation of moisture, there appears to me another good effect to be got by not inverting too thoroughly the residue of the previous crop, and that is the prevention to some extent of the formation of that extremely hard layer, often not more than a quarter inch thick, which forms on the surface of stiff soils, or even on light ones if there is a tendency to efflorescence of white salts. These salts, though present in the soil in such small quantity as not to be directly very harmful to vegetation, may, when collected at the surface by evaporation, cement the particles of the upper quarter-inch of even a light soil till it has almost the consistency of rock and completely strangles vegetation.

The formation of this hard layer may, by this practice, be modified partly by the lesser concentration of salts at the surface owing to the mulch, and partly to the greater admixture of organic matter of previous crop residues in the upper layer of the soil where the salts concentrate.

I have never seen the surface of a slightly salt soil in which there is an excess of organic matter harden as I have seen that of even an extremely light sandy one.

In the event of there being anything in this idea that the native plough tends to conserve moisture and prevent caking of the surface soil more than an American or English plough does, it does not mean, I hope, that the native plough will be left in undisturbed possession of the field.

To me the native plough appears an implement with a good deal to recommend it to the native agriculturist.

Its low initial cost; the almost impossibility of breaking it; the ease with which it can be repaired if it is broken; its comparatively wonderful effectiveness when properly handled, and

other advantages, all stand in its favour, but I think there are other implements already in the market, or which could be made, which could replace it to some extent with advantage to the farmer.

The native plough, as I have said, differs essentially from the British idea of a "plough," in that it does not turn the furrow, and appears to me to be more comparable to the implement called a "cultivator."

This suggests to me that a good strong implement of this type, having not too many "tines" or "teeth," so that the draught would not be too heavy for two bullocks, might replace it with advantage, at least in some tillage operations, and give practically the same effect as regards the inverting the soil as the native plough does.

Some of the advantages of the "cultivator" are :—Having a number of tines set in a frame at regular distances, there is less chance of patches of the land being "miseed" by careless workmen.

A much greater area is covered : a point which in these days of scarcity of labour is worth considering, and they are simple enough to be worked and understood by anyone.

The repairing of these implements is, I know, a difficulty, as also their initial cost, but these difficulties will tend to lessen in time.

As more iron implements are brought into use, the blacksmith will become more common in the community, and as the calls for his services to repair such implements become more frequent, his knowledge of them will increase as well as his stock of necessaries for their repairs, and with these the present difficulty of the rayat will lessen.

The difficulty of the initial cost will diminish when it is proved that the implements are worth the money.

The "Sohaga," from its consolidating action on the upper layer of the soil, is not the best implement to put last over a piece of tilled ground not to be immediately flooded with water, and required to retain its moisture well.

Again, in relation to the economical use of the soil moisture, we have the problems of finding out the relative amount of water required by each of the common crops during a growing season, the best arrangement of crops in a rotation from this point of view, and many other questions far too numerous for me to say anything about in such a note as this.

It will be quite satisfaction enough for me if I have achieved in some measure the object with which I set out.

CASSAVA AS FAMINE FOOD.

By F. BOOTH-TUCKER.

While travelling in Travancore last January, I learned from inquiries that the high prices of rice and other staple grains had reached even this distant and comparatively isolated corner of India. Yet the people seemed unusually prosperous and well-fed.

Famine, I was told, had been unknown for the last thirty years, in the sense in which it afflicted other parts of India. Droughts there had been, and scarcities, and high prices, but the necessity for extensive relief works, or the decimation of the population by famine deaths, were things unknown to the present generation.

My informants pointed to the familiar Cassava plant, a plot of which was attached to every cottage home and the cultivation of which had now become practically universal.

Each acre could produce from five to twenty tons of the tuber, so that a small patch would supply an entire household with food and render them independent of the fluctuations of the grain market. The rains may fail and rice may be dear, but there is always an abundant supply of the drought-resisting "Marachini" to fall back upon.

We were the guests of a retired Travancore Judge, and were thus in a good position to gain the most reliable information possible. Specimens of the raw tuber were shown us, and in different forms it was included in the generous diet which our kind hosts had provided for us.

What struck me, however, most of all was the *Indianisation* of the Cassava in Travancore. To persuade Indians to take to tubers as a staple article of diet had always appeared to me an

almost hopeless task. As a mere "bonne bouche," appetiser, or addition to their vegetable curries, or as an enforced but disliked "dernier ressort" in case of actual famine, its popularity would be limited and there seemed little hope of securing for it a place amongst the staple foods of India.

Here in Travancore, however, a simple device had been adopted which, I could see at a glance, placed Cassava amongst the front rank foods of India, and gave her the entrée to all castes and classes of the people.

The roots had been boiled, cut and sun-dried for purposes of preservation. The next step was an easy one, to reduce it to powder with an ordinary rice-pounder or country hand-mill. It then made a delicious and tasty flour, very wholesome and capable of being mixed with other forms of flour.

The next inquiry was naturally in regard to prices, and here I was glad to find that it had not so far been affected by famine conditions. In ordinary seasons the price of the sun-dried product ranged in various localities from 20 to 40 seers per rupee.

Cassava land, I was told, rented as high as Rs. 25 per acre and brought in an income to the cultivator of from Rs. 100 to Rs. 150. Hence it was a profitable crop to the agriculturist, and with a wider market would become still more so.

The next difficulty was the question of transportation. It was obvious that unless the new food could be carried at a reasonable rate, it would be impossible to deliver it in the famine regions at such a price as would enable it to be of any use to the people.

Another more serious difficulty to overcome was the universal incredulity on the part of all concerned (outside Travancore itself) as to the willingness of the people to take to any kind of new food.

However, persistence and enthusiasm in a cause, regarding the ultimate success of which I entertain no shadow of doubt, has enabled us in a large measure to overcome the initial difficulties.

The leading Railway Companies have consented, at least temporarily, to admit the new intruder to the same privileges as other staple articles of the people's diet, instead of placing it on

the shelf among luxuries denied to all but the rich and well-to-do. In this we have received some assistance from the Railway Board.

In regard to the circulation of the new food, I have consulted freely with Indian grain merchants. Indeed, it has been here that I have received the largest measure of co-operation and support, the importance of which it is impossible to exaggerate.

I have felt from the first that if we could create a demand for the article on the part of those who had their fingers on the pulse of the food supplies of India, success would be assured. They would see to it that the agriculturists of India were made acquainted with the merits of Cassava, and would make suitable arrangements for a supply commensurate with the demand.

Calling personally on some of the leading merchants of the bazaar, I showed them Cassava, both in its sun-dried form and when reduced to flour. They liked the taste and appearance, experimented with a small quantity and then ordered several maunds for further trial. They then tasted it by itself and also when mixed with other kinds of flour.

So satisfactory was the result, that I have already received orders for a supply of about 1,000 maunds, and have been asked to make arrangements for a regular and steady supply of the article. In addition to this, spontaneous requests have been made by these merchants for full information as to the cultivation of Cassava and for a supply of cuttings, with the assurance that a considerable amount of land will be planted with it during the present season.

Being anxious to spread the experimental operations over as wide an area as possible, we have tried the Cassava in our Salvation Army Boarding Schools for boys and girls not only in Travancore, where it is already known and liked, but in the Deccan and the Punjab, with the result that the children have taken readily to it, and have asked for it to be made a permanent part of their bill of fare.

Arrangements have also been made for planting Cassava on our Farm Colony in Gujarat near Ahmedabad, and also at

Ahmednagar, Bareilly, and other places where we have land, with a view to exploiting it in the various neighbourhoods.

One hundred maunds of the Cassava have been ordered by the Famine Commissioner of the U. P. for experimental use at the poor houses in Gonda and Bahraich, the labour of the women being utilised to reduce it to flour by means of the ordinary *chakki*. The district officers report that there has been no difficulty in getting the people to adopt it as part of their diet.

It may, therefore, be fairly assumed that Cassava in its sun-dried and flour form has now made a successful début both as a Famine fighter and as a permanent and popular article of diet in India.

The importance of this it seems difficult to exaggerate.

1. Cassava will grow in almost any part of India, and is already to be found in districts so widely separated and differing in climate as Nepal, Darjeeling, Assam, Bengal, Madras and Travancore.

2. The root will resist drought and can be left in the ground a considerable period after maturing, without requiring to be rapidly and simultaneously harvested, and is immune from the attacks of white ants.

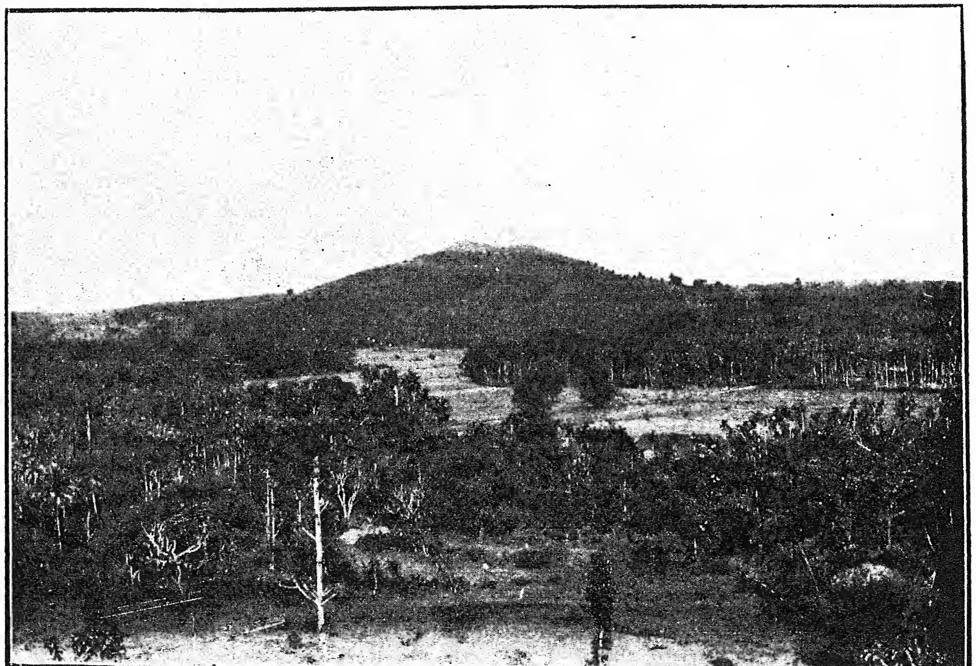
3. In its sun-dried form it will keep for a year and is very convenient for transportation and cannot be mixed with deleterious articles.

4. It is easily cultivated and is a very profitable crop.

5. Countries where it is well known and largely grown, such as South America, East and West Africa, Madagascar, etc., while liable to droughts and scarcities, are said to be absolutely immune from the ghastly death-roll and depopulation, which so frequently accompany Indian famines.

6. In its flour form the universal prejudice against the use of tubers is dealt with and overcome.

PLATE XXXIII.



A. J. I. VIEW OF A VALLEY ON THE WEST COAST, SHOWING THE MAIN VALLEY WITH PADDY CROP, AND HIGH LEVELLED LANDS ON THE LEFT OF MOUNTAIN.

LEAF MANURING IN SOUTH CANARA.

By M. E. COUCHMAN, I.C.S.,

Director of Agriculture, Madras.

One of the most interesting and important duties of the Agricultural Department will be to ascertain, by detailed local enquiries, what use is made by the cultivators of each tract of the sources of manure available to them. A few notes regarding the agricultural practices of the District of South Canara, in the Madras Presidency, may therefore interest some readers of the Journal.

The District is a narrow strip of land lying between the western ghauts and the sea. Originally a laterite plateau, this has been cut up into deep valleys by numerous rivers rising in the hills, fed by a rainfall of from 120 to 200 inches. The valley bottoms have been converted into rice-lands, which extend to varying distances up the sides of the hills, according to the steepness of the gradient, and the pressure of population. In the adjoining district of Malabar, where there is a larger population, many of the hills have been carved into terraced fields to the very summit (Plate XXXIII). In South Canara the slope of the hill is covered with scrub jungle, but when the top of the hill itself is reached, it is usually seen to be a bare plateau, covered with short grass during the rainy month, and almost bare in the hot weather. In many parts the surface is mere laterite rock on which nothing will grow. Rice is practically the only crop grown. The almost continuous rain which falls in June, July, August and part of September suffices to grow the first crop of rice. For the second crop, dams of brushwood and earth are thrown across most of the larger streams, and the numerous springs which flow from the steep

laterite hills are carefully trained along the sides of the valleys. Where these are insufficient, shallow pits are sunk in the corners of the fields and the water is baled from them by a picotah of peculiar construction. Instead of two men walking to and fro on the top of the lever, a number of ropes are attached to the end remote from the bucket. A hole about 6 feet deep is dug beneath this end of the picotah, with steps cut in one side. Four or five women and children hold the ends of the ropes, and when the bucket is full, they throw themselves backwards into the hole, thus pulling up the bucket. They then walk up the steps cut in the side of the pit, and so the work goes on. It has this advantage over the picotah of the East Coast, that whereas the latter requires strong and well-trained men, and there is always some danger of the men falling from the lever, the South Canara picotah renders the cheap labour of women and children available, and is perfectly safe. In some parts a third rice crop is grown, but this is almost invariably by lift irrigation throughout. The usual practice is as follows.

In April and May parts of the low-lying lands are well ploughed in the dry, and dry seed-beds prepared, the seed broadcasted and ploughed in. In many cases the "mango showers" suffice to germinate the seed. These seed-beds are called "dust seed-beds," and the seedlings raised from them are considered more robust than those raised in wet seed-beds. Where there is not sufficient moisture in the soil, the seed-beds are irrigated from a shallow tank or well with the picotah described above. Seedlings raised in this way, with what is called "old water,' *i.e.*, before the south-west monsoon rains commence, though not so good as those grown in the dry beds, are preferred to those sown after the burst of the monsoon. The monsoon usually bursts about the end of the first week of June. By this time the seedlings are almost ready for transplantation. The lower-lying lands are hastily prepared and transplanted soon after the middle of June, the higher-lying lands being planted as soon as cattle and labour can be spared from the work on the more valuable low-lying fields.

PLATE XXXIV.

A. J. I. Ploughing lands for second crop. Surrounding jungle available for cutting leaves.

Harvest of the first crop on double crop lands begins soon after 15th September. Seedlings for the second crop have in the meantime been prepared in a field left vacant for the purpose. The stubble is hastily ploughed in, manure applied, and the second crop planted in October. This is harvested about the end of January. Where a third crop is raised, this is put in soon after the harvest of the second, and harvested about the middle of May.

From this short account of the ordinary methods of cultivation, it will be clear that a severe strain is put on the fertility of the soil. The same cereal crop is raised year after year, and in some cases rice is on the ground for eleven months out of the twelve. The torrential rainfall washes most of the soluble plant foods from the soil, and land left uncultivated soon becomes incapable of growing anything but a little coarse thatching grass. The object of this paper is to describe some of the methods by which the cultivators maintain the fertility of their lands as no oil seeds are grown except a very small quantity of gingelly for domestic consumption. No cake-manures are available. Neither is there any *pungam* or *neem.* The cocoa-nut cake is either exported or used as cattle food. There are no sheep and very few goats. "Penning" is, therefore, out of the question. Some fish manure can be obtained, but this is mainly used for tobacco.

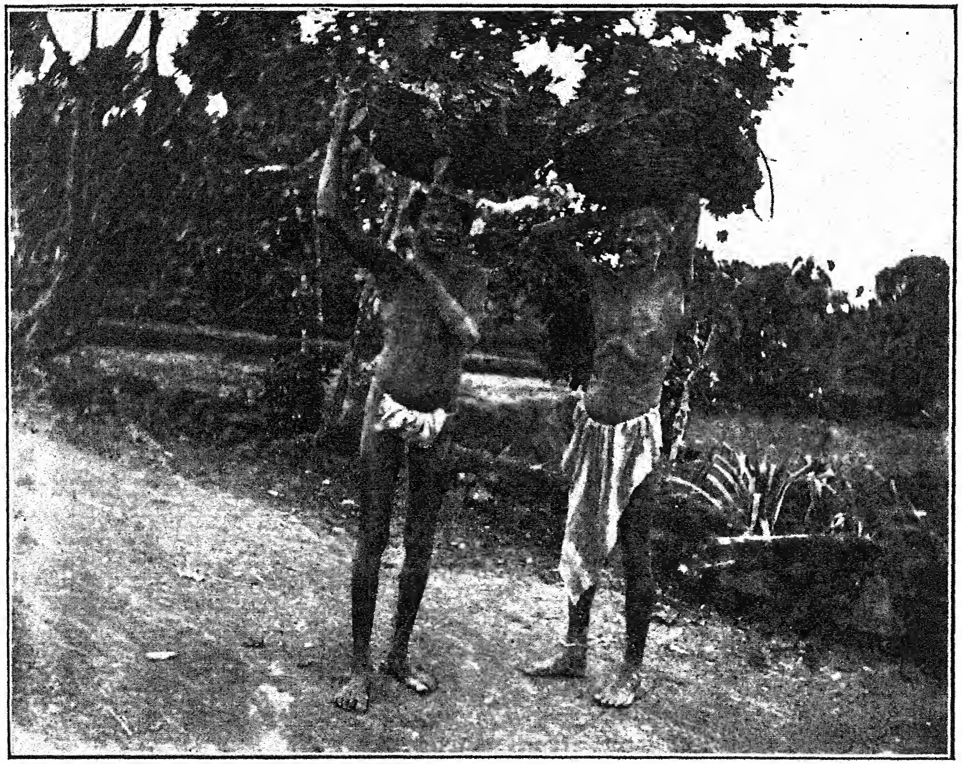
The sheet anchor of the South Canara ryot is his leaf manure. As a rule, the exclusive use of 100 yards of the slope of the hill lying above his land is permitted to the ryot free of all charge (Plate XXXIV). A wall and ditch are put round this, and the jungle is strictly protected by the ryot. He does not, as a rule, cut the green branches from the trees in this land, but contents himself with sweeping up the fallen leaves. Beyond this lies the open hill-side, and the plateau on the top. Outside reserved forests, anyone can cut and remove green leaves and twigs from tree growing in this area. With the heavy rainfall and equable moist, warm climate the growth of all vegetation is extremely rapid, but the incessant industry of the ryots keeps all growth down to a low coppice about 18″ high. In the more thickly populated

parts, the continuous severe cutting of green leaves and twigs has killed out all growth. In some villages the ryots combine to reserve a portion of the waste land in the same way as individuals protect the 100 yards of land immediately adjacent to their own. No green leaves are then cut, the dead leaves alone being swept up. More commonly the ryots of each village content themselves with keeping the jungle-growth on the waste lands within the boundary of their village for their exclusive use. Different methods are in vogue to secure this object. Sometimes it is declared to be dedicated to some local god or demon, and an annual ceremony performed to impress the minds of outsiders. The efficacy of such methods, however, is not what it was. The writer once asked the people of a village how they managed to keep the jungle-growth on the waste lands of their village so good as it was. "We make a *bundobust*," they said, "to prevent the people of the other villages cutting it."

"I suppose that means that if the people of other villages come to cut your leaves you collect your tenants and give them a good hiding."

The deprecating smile which followed showed that this had hit the mark. Throughout the year the spare time of the ryot and his family is fully employed in cutting green leaves from this unreserved land. The leaves are tied into a bundle as large as can be carried, and taken home. The heavy rainfall makes it absolutely necessary to provide some shelter for his cattle, and the South Canara ryot has evolved for himself a simple and effective form of loose-box which makes the best possible use of the leaf-manure. A pit is dug to a depth of about 4 feet. The other dimensions depend on how many cattle he has. A light thatched roof is built over this and the sides are fenced in with railings. At night the cattle are driven in from the hill where they have been grazing all day, and as a rule tied separately to posts, grass or straw being sometimes placed in front of each. The cattle are kept in the shed till about 8 A.M. the next morning. The floor is strewn with a covering of leaves renewed every day. Where leaves are scarce, the paddy stubble

PLATE XXXV.



A. J. I. COOLIES CARRYING LEAF-MANURE TO THE FIELDS FROM CATTLE SHEDS.

is pulled up by hand and used as litter. The pit will be full in about a month. The leaf-manure, which has absorbed the solid and liquid excreta of the cattle, is then removed and either put in a heap or pit, or taken straight to the field where it is to be used, and stacked in a corner, if there is a growing crop already on the ground. If the ground is bare, it is placed in heaps over the field till it can be ploughed in. All the green leaves and leaf-manure from the cattle sheds *have* to be carried in head loads, the use of carts being impracticable owing to the hilly nature of the country (Plate XXXV).

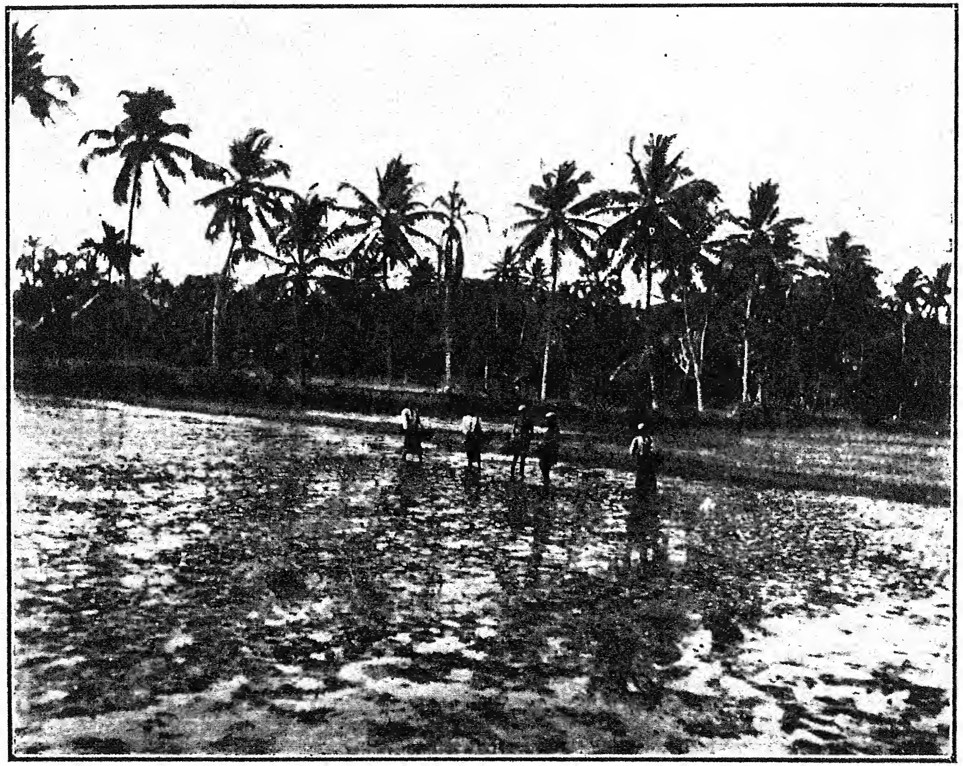
It will be seen at once that this system utilizes to the full both the liquid and solid excreta of the cattle, and produces a very rich fertilizer. At the same time the leaves and sticks improve the physical condition of the soil. The system is possible, because wood is almost always available for fuel, supplemented by the leaves of the cocoanut and palmyra palm. One would, however, like to get at the impartial opinion of the cattle on the subject. Their sleeping place is neither clean nor sweet smelling.

Where labour is available, the crop is always transplanted. In some cases the seed is steeped in water for a day or two, and then mixed with well-rotted leaf-manure and ashes in the proportion of one basket of seed to ten of manure, and either dropped in small handfuls all over the surface of the puddled field (Plate XXXVI) or sown behind the plough, in the same way as castor, etc., are usually sown in other parts. The latter system can, of course, only be practised when the land is ploughed and sown in the dry. This is, therefore, only done for the first crop and with unsteeped seed. Other manures applied to the paddy fields are wood ashes, which are carted to long distances from the large towns, and "burnt earth," a compost of leaves and other rubbish mixed with soil and burnt. Where the ryot has not sufficient cattle to pass all his leaves through the pen, he applies them direct to the field. For this purpose green leaves are preferred. Before leaving the subject of leaf-manure, one more practice must be described. Cocoanut trees which are grown in gardens are usually heavily manured

with cattle dung, etc. The trees which are scattered along the bunds of the fields as a rule receive only the following treatment. A deep circular pit about a yard deep is dug all round the trunk, and this is filled with the leaves and boughs of the *Nux vomica* tree, which is extremely common here. These are then covered up with soil. It is believed that this not only acts as a stimulant to the tree, but protects it from boring insects.

Apart from manures, the chief means by which the fertility of the wet lands is maintained, is by growing leguminous crops after paddy. In the case of the lower-lying one-crop lands, these are sown in September—October, and in the case of two crops in January—February, where the soil is sufficiently retentive of moisture. Horse-gram (*Dolichos biflorus*) is usually broad-casted in the standing paddy shortly before the paddy is cut. For green and black gram (*Phaseolus mungo*), the best cultivators plough up the stubble, apply ashes, and secure a fine tilth before sowing the pulse crop. The whole plant is removed when the grain is ripe, but so well is the beneficial effect on the soil of the leguminous rotation understood, that in some places ryots who cannot sow the pulse crop themselves will permit others the free use of their fields for this purpose. It is hoped to introduce ground-nut on the sandy soils, as an alternative to these pulses. Though some irrigation would be necessary, it would be more profitable, and at the same time the cake would afford another source of manure. "Green-manuring" in the sense of growing a leguminous crop on the ground to be ploughed in at the time of transplantation is quite unknown here. As leaf-manure becomes scarce, with the destruction of the jungle, it will be one of the chief problems of the Agricultural Department to see if it can be replaced to some extent by green-manuring.

PLATE XXXVI.



A. J. I. SOWING SPROUTED SEED, MIXED WITH DECAYED LEAF-MANURE, IN PUDDLED PADDY FIELD. (SECOND CROP).

IMPORTED INSECT PESTS.

By H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S.,

Imperial Entomologist.

In almost all countries where Agriculture is of any degree of importance, measures are taken to prevent as far as possible the introduction of insect pests; in some countries these measures are stringent and the importation of living plants, for instance, is conditional on their being fumigated at the port of entry so as to minimise the danger of bringing in a harmful insect. Unquestionably many of the more virulent pests of the world have been spread from one country to another by commerce, and it is almost a law of nature that such introduced insects shall, once established, be far more destructive in new places than in their original habitat.

In this country, there are no such measures of precaution, except in the case of American cotton seed, which is fumigated at the ports of entry to ensure the destruction of the weevil, which in the Southern States works such havoc in the cotton boll; the question has often been mooted and, on general grounds, it would seem that India should follow suit and adopt precautionary measures.

It is of interest to first consider whether in the past, with a large volume of trade with other countries, with an entire absence of any restriction or precaution, any undesirable and injurious insects have been introduced; among the common pests of Indian Agriculture, are there any that are likely to have been imported by commerce, or are there natural circumstances which protect India from such invasion? Evidently such an enquiry is the preliminary to any further action, and unless we have data of

this kind, we are not in a position to form an opinion on this difficult question.

We propose here to give such facts as throw a light on this subject; in a later paper we propose to consider, first, those pests that are not now in India and that might come in, and second, the nature of the imports that would bring them in and the volume of trade that would have to be dealt with in any precautionary measures.

It is possible to make a list of the more important pests of crops in India and to tabulate them according as we know them to be indigenous or introduced, or as we believe, from all the available facts, that they are indigenous or introduced; we have also to consider whether introduced ones have been brought in by man (and so preventably introduced) or by nature. It is impossible here to take each insect and give all the facts on which to place each one; we select a few typical examples and deal with them as an illustration of the method used in tabulating each one.

A very common and widespread insect is the sweet potato weevil (*Cylas formicarius*); its grub lives in the sweet potato in the soil; it is found constantly all over India, and has been recorded from India for more than a century. It was first described from specimens that came from Java, India or some part of the Indo-Chinese region, and for long was regarded as a rarity. It has since been found in Australia, the West Indies, the Southern States of America; in all of these places it has been found only during the last forty years, and in them it is not widespread or universal, but occurs only here and there. It has the appearance of an indigenous insect in India and Java, of an introduced insect elsewhere; we place this among our indigenous insects.

Another instance is the notorious potato-moth (*Phthorimæa operculella*), whose caterpillar lives both in the plant and in the tuber, whether in the ground or stored; in India this is now known to occur in potato-growing tracts in Bombay, in Bengal, in the Central Provinces, in Madras; in some of these places seed potatoes have been imported from Europe for some years past; in

many, the potato-growers state that the pest is of "recent" origin, naming ten or twelve years or similar periods. The pest is apparently absent in parts of Bengal, where seed potatoes are usually obtained from the Himalayas. In Europe the pest is known to occur in countries round the Mediterranean ; it occurs also in Australia and in America. Its native home is in doubt, but it is undoubtedly a recent introduction to India, brought in with shipments of seed potatoes probably from Italy. This is perhaps the most decisive case of an introduced insect that can be named.

We may take as another example, the American bollworm (*Chloridea obsoleta*) ; in the United States this is a pest to cotton, to maize, to tomatoes, etc. It is practically world-wide in distribution ; in India it attacks gram, opium, tomatoes, pulses, etc., a few wild plants, and out of hundreds of cases, only once has it been found to attack cotton. It is widespread in India, occurs abundantly and has the characters of an indigenous insect. No one can now say where this insect first started from ; it is extraordinarily omnivorous ; it is like the sparrow in its disregard of heat and cold ; it is as likely to have originated in India as in America, and it may be classed as an insect that has, without the intervention of man, spread over almost the entire inhabited world : we can find no evidence of its being an introduced enemy, or if it is, it may have been a natural introduction before agriculture flourished in India.

Another case is of interest ; the commonest butterfly in India next to the Akh butterfly (*Danais chrysippus*, Linn.), is the beautiful butterfly whose caterpillar feeds on orange, lime and lemon trees (*Papilio demoleus*). This occurs also in South Africa, and geologists tell us that there is an affinity between the fauna of India and South Africa, because they were once connected by a Continent. Is this insect indigenous to both, or did one send it to the other ? It has in India all the characters of an indigenous insect, and we can find no evidence to place it in one rather than in the other table. For our present purpose we may class it as an indigenous insect, not likely, from its habits, to have been capable of introduction artificially by man.

The Death's-head Moth (*Acherontia styx*, Westw.) has a wide distribution over temperate and tropical Asia; it has in India the character of a well-established and indigenous insect, feeding not only upon cultivated but on wild plants. It is a strong flier and is extremely likely to have distributed itself naturally over the area in which it is now found; at the same time, there is no stage in which it is likely to be carried by commerce, since the chrysalis in the soil is the only long dormant stage in which food is not required. We place this as a natural introduction or an indigenous insect.

The Surface Caterpillars are a well-known form of pest in India as elsewhere; our two common species (*Agrotis ypsilon*, Roth. and *Euxoa segetis*, Schiff.) have a wide distribution outside India; the group as a whole is characteristic of temperate climates, a vast number of species living in Northern Asia and Europe; there is reason to believe that one species (*E. segetis*, Schiff.), has actually spread from the Himalayas through the hill forest areas of India and established itself at altitudes of 2,000 feet and upwards; whilst the other (*A. ypsilon*, Roth.) actually appears to migrate annually from the Himalayas to the neighbouring plains for the cold weather, the March brood returning to the hills again. These are, we think, clear cases of natural spread of a temperate climate species into a tropical climate by a process of adaptation, and we class these as natural introductions.

We may take another instance from the moths; the Castor Semilooper is one of our more virulent pests; it is common to Africa, South Eastern Asia and Australia; it is very difficult to see how such an insect could have been carried artificially to India; it has a common cultivated food plant, castor; it has a very common wild one, *Euphorbia pilulifera;* and we consider the probabilities are that it has spread naturally over these regions without the intervention of man.

The above cases illustrate the way in which it is possible to decide whether to class an insect as indigenous or introduced. By applying this method and by taking into account the

habits of the insect and its possibility of introduction, it is possible to tabulate our pests into the classes given above.

In order to give shortly the result of such an examination of our injurious insects, we may take them group by group. Of injurious grasshoppers, locusts, crickets and the like, we can class none as certainly introduced; the migratory locust (*Schistocerca peregrinum*, Oliv.), is believed to be of South American origin, but it has undoubtedly established itself in North India by purely natural means. With one exception, it is extremely difficult to see how any of these insects could be artificially introduced and we may class our ten or twenty as all indigenous; the mole cricket (*Gryllotalpa africana*) is a possible visitor, its distribution being wide, but it has the characters of an indigenous insect. Of the bees, wasps, and ants, one sawfly and two ants are injurious; but they are distinctly indigenous and, though commerce may have brought in ants that are a nuisance in our houses, no real pest has been brought in.

We come next to the beetles; confining ourselves for the moment purely to crop pests, there is no single beetle we can point to as an introduction. The extraordinary statement has been made that injurious lady bird beetles were introduced from Australia by the coffee planter sent to find an enemy of the coffee-scale, but there is no foundation for this statement in fact, as the supposed introduction is an indigenous insect.

Of the butterflies and moths, we can mention the potato-moth as a certain, and the Diamond-back Moth as a possible, introduction by man; we can mention also a small number of species, such as the American Bollworm (*Chloridea obsoleta*), the army worm (*Cirphis unipuncta*), the indigo caterpillar (*Caradrina exigua*), the greasy surface caterpillar (*Agrotis ypsilon*), which are very widely distributed over the earth, but which, there is no reason to think, are other than natural introductions or indigenous insects; they owe their wide spread to their omnivorousness and their adaptability to climate, not to man, just as the Akh butterfly (*Danais chrysippus*) and the painted lady (*Vanessa cardui*) do, these being quite harmless

species. In fact, out of over eighty species, there is nothing to point to more than two species as introductions by man.

With the flies, we come to debatable ground, and the origin, for instance, of the common gourd fly (*Dacus cucurbitæ*, Coq.), may be put in India or China at will. But there is no reason to believe that any destructive fly has been introduced by the agency of man, rather that India has possibly given forth such species as the melon fly to be a scourge to other countries.

Finally, we come to the sucking insects, the bugs, Aphides and scale insects; taking the bugs apart from the Aphides and Coccides, it is impossible to fix on any species that may have been introduced; our dozen or more destructive species are indigenous. Of the Aphides (the Greenfly and Plantlice), the reverse is the case; our injurious species are world-wide, either because they have been spread artificially or naturally, or because it is very difficult to find characters by which to distinguish species; our six most injurious species are of wide distribution, and it is impossible to say that it is either natural or artificial. The probabilities seem to be that they are introduced, but it is by no means certain. Of the mealy bugs and scale insects (*Coccidæ*), we have more definite data on which to decide. No one would regard the green bug of coffee (*Lecanium viride*, Gr.) as indigenous; the brown bug (*Lecanium hemisphæricum*) of coffee is probably an introduction, as may be the coffee root bug (*Dactylopius citri*) and some others; in fact, of the 109 recorded Indian mealy bugs and scale insects, 79 are indigenous, 6 are doubtful and 24 are introduced. It may be remembered that scale insects are very small and fixed to the plant, that they are often dormant for long periods on the plant, and that they are often parthenogenetic, requiring only the introduction of one female to start the species; it is thus that they are so frequently carried from country to country on plants and that there are so many recorded cases of actual introductions of these injurious insects.

This completes our review of the insects injurious to crops; if we include also insects injurious to grain, flour, stored produce, etc., we get the following facts; out of thirty species, twenty

are "cosmopolitan," some of which probably originated in India (*Calandra oryzæ*), while others have undoubtedly been spread by man and brought into India in merchandise. Probably fifteen out of our thirty have been so introduced.

What is the total result? Of our crop pests, exclusive of scale insects and mealy bugs, out of 213 species injurious in some degree, two moths and six aphides are possible introductions; out of 109 scale insects, 24 are probably introduced and of the most injurious ones, eleven out of fourteen are introduced: of thirty grain pests, probably fifteen are introductions. These facts mean that, of our important pests, only a very small proportion have been introduced, that these are either scale insects, grain pests or special insects, and that, as a whole, our crop pests are those produced by nature in the country and not those brought in by man. We may attach little importance to the scale insects that have been introduced because they are, as a rule, comparatively harmless in India; only permanent crops such as tea and coffee suffer from such insects and, while coffee is the prey of the green and brown bugs, it is much more the victim of depression, and the tea industry, if it suffers at all, suffers from indigenous rather than introduced species.

We may wonder why so few pests should have been brought in and, though one can but theorise, it is worth consideration. The principal fact to be borne in mind is the difficulty an insect would have in establishing itself and spreading, on account of the climate. In temperate regions, cold is the insect's enemy, and every insect meets this by dormancy. In India, fierce dry heat is the insect's enemy, and the greatest check in insect life is that period before the rains when all is parched and very hot. We know that insects, accustomed to a cooler, moister climate, have wandered into India and adapted themselves to the climate; the mustard Sawfly (*Athalia proxima*) is dormant from March to November; the cabbage white (*Pieris brassicæ*) goes to the hills in April; the wheat aphis (*Toxoptera graminum*) seeks shelter in the depths of the grass roots; in different ways insects adapt themselves, but these have probably done it gradually,

moving in from cooler to hotter areas step by step. It is probable that it is practically impossible for an insect to establish itself, if not accustomed to such a climate; and we believe this to be the great safeguard, the real reason why Indian pests are Indian, and are not cosmopolitan or European. Were India bounded on the North by agricultural countries with a profusion of pests, many more might have wandered gradually in; India is an isolated country and it is likely that those pests brought in by man failed to establish themselves owing to the rigours of a climate they were wholly unused to, unless there were very special circumstances, as in the case of Scale Insects on plants, or weevils in flour or grain. The evidence derived from an examination of the origin of our existing agricultural pests is re-assuring and, with the few prominent exceptions, points to a natural immunity from undesirable introductions, due partly to the natural isolation of India, but largely to its climate.

ARTIFICIAL FERTILIZERS FOR COTTON, CENTRAL PROVINCES AND BERAR.

By D. CLOUSTON, M.A., B.SC.,

Deputy Director of Agriculture, Central Provinces.

IT has been repeatedly pointed out that the black cotton soil of the Central Provinces and Berar is deficient in humus, the great source of nitrogen in any soil. The supply of farm-yard manure available is altogether inadequate to meet this want. Moreover, the decomposition of organic matter is much more rapid than it is in temperate climes, and is still further accelerated by the free aeration of the soil owing to its peculiar nature of cracking. White-ants also play an important part in consuming vegetable matter in the soils. The cropping systems in vogue, too, tend to exhaust the soil's natural fertility without giving anything in return. In the cotton tract especially, the cultural methods and rotations practised are of an exhausting nature. Much of the crop, including cotton, gram, linseed and wheat, is pulled up by the root, so that the amount of crop refuse left in the field is very little. In this tract, moreover, cotton or cotton rotated with juar is grown year after year in the same land at the expense of leguminous crops, the chief soil-renovators made use of in other tracts of the provinces. So long as the price of cotton remains as high as it is at present, there is little hope of the cotton growers paying much attention to rotations unless an equally profitable crop can be found to rotate with it. The cultivator naturally looks more closely to his immediate profits than to the question of soil exhaustion and pecuniary loss 20 years after this does not matter so much to him.

(2.) The greatest need of cotton growers in these provinces at the present time is an additional supply of manure to meet the loss sustained by constant cropping. Artificials in the form of nitrate of soda or sulphate of ammonia will, we believe, to some extent meet this want. The series of experiments with artificial manures that is now being carried out at the Nagpur Experimental Station has so far given strong evidence in favour of this opinion. Great care was again taken this year to secure an equal number of plants on each plot; the number on each after the last thinning being 1,664, or at the rate of 16,640 per acre. To these plots the manures were applied at the rate of 126 lbs. of nitrate of soda, 80 lbs. of sulphate of potash and 360 lbs. of superphosphate per acre; these supplied 20 lbs. nitrogen, 35 lbs. of potash and 50 lbs. phosphoric acid respectively.

The results are tabulated in the following statement :—

Plot.	Manure applied.	Outturn in lbs. Seed cotton per acre.	Increase or decrease in lbs.	Value of increase or decrease.	Cost of manure.	Net profit or loss.
				Rs. A. P.	Rs. A. P.	Rs. A. P.
1	Nitrate of soda, superphosphate and potash	739	390	43 14 0	30 7 0	+13 7 0
2	Nitrate and super ...	669	320	36 0 0	25 5 0	+10 11 0
3	Nitrate and potash ...	705	356	40 1 3	20 3 0	+19 14 3
4	Nitrate	650	301	33 14 3	15 1 0	+18 13 3
5	Potash and super ...	381	32	3 10 6	15 6 0	−11 11 6
6	Super	245	−104	−11 10 9	10 4 0	−21 14 9
7	Potash	325	−24	−2 10 9	5 2 0	−7 12 9
8	No manure ...	349	...	...	...	...

(3.) Nitrogen is conspicuously deficient in this particular soil, and the effect of the nitrogenous fertilizer in increasing the outturn is, therefore, surprisingly great. Without it, potash and phosphate are apparently altogether ineffective. The gain due to superphosphate and potash, when applied along with nitrogen, though considerable, will not justify us in assuming that these are deficient in this soil. Nitrogen is the all-important constituent, and when applied in *such a soluble form* is a highly forcing manure. The increased growth due to it makes heavy demands on the other important constituents of plant-food, *viz.*, potash and phosphate, within the short period of three months, *i.e.*, from the time of applying the nitrate to the time the cotton matures.

The application of the other two constituents enables the nitrate to exert its full effect in this short period of time.

(4.) From an economic point of view, nitrate of soda has proved to be a most profitable manure despite the fact that the price paid for that manure, including, as it does, freight charges on small lots from Calcutta is abnormally high. It would be bad agricultural practice, however, to apply only quick-acting fertilizers to a soil that is so deficient in organic matter as is the black cotton soil of these Provinces. What is required is some organic manure such as cattle-dung with an additional dressing of a highly soluble nitrogenous fertilizer. To ensure a liberal supply of potash, the urine should be carefully conserved along with the dung.

(5.) The experiments started last year at the Akola Station with the object of ascertaining what is the best combination of these to apply, failed to throw any light on the point owing to the abnormal character of last year's Kharif season. The outturn of cotton on three-fourths of the cotton tract was 50 per cent. below that of a normal crop. The growth of the plants being stunted by the excessive and continuous rains of July and the first half of August and by the severe drought which followed, cotton suffered more than usual from stem-borer this year. Nitrate of soda would seem to be a most effective preventive of this pest. Of the 13,312 plants grown on the 8 plots of the series, only 6 plants were found affected with stem-borer, and these were all found in the last four plots, *i.e.*, the plots that got no nitrate of soda. It was noticed, too, that other cotton manured with this fertilizer on the farm was free of stem-borer. It is just possible that the use of such quick-acting nitrogenous manure may prove the most economical method of preventing pests of this kind which usually attack stunted plants that have suffered from untoward conditions of weather or soil.

(6.) The best time to apply the fertilizer is another problem that requires to be solved. The experience gained last year has convinced us that in the Central Provinces and Berar, where an early and sudden cessation of the rains is always possible,

top dressing is not an altogether satisfactory method of applying nitrate of soda. If applied before the plants have reached a height of about 9 inches, it kills some of them, while if not applied till the plants are sufficiently strong, there will be the risk of not getting a late shower to dissolve the fertilizer, as happened this year. Taking one year with another, it will most probably be found that these fertilizers are most effective when applied at the time of sowing.

(7.) Whether nitrate of soda or sulphate of ammonia is to be the more suitable manure for the needs of cultivators in these Provinces is another problem that we hope to solve shortly. The latter is to be manufactured in these Provinces, and it should be possible to make it on the spot at a much cheaper rate per unit of nitrogen than is paid for the imported material. Moreover, sulphate of ammonia being a less soluble manure, the proper time to apply it is at the time of sowing. With a short and capricious rainfall, this too will undoubtedly be in its favour.

(8.) Nearly two tons of nitrate of soda were either sold or given gratis last year to members of the District Agricultural Associations, mostly in Berar. For reasons already explained, no definite results are likely to be obtained from these trials. In most cases the manure was not applied at all as the rains ceased before the plants had attained the height at which it should have been applied. The only cultivator who has yet reported the results obtained an increase of 212lbs. of unginned cotton from the use of nitrate of soda at the rate of one-half cwt. per acre.

IMPROVEMENT OF CATTLE IN BENGAL.

By E. SHEARER, M.A., B.SC.,

Imperial Agriculturist, Agricultural Research Institute, Pusa.

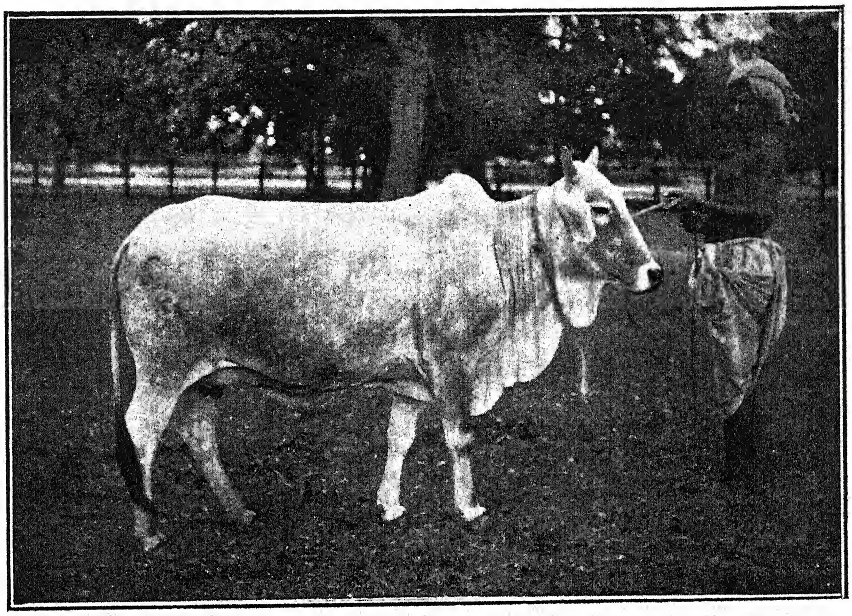
FROM the point of view of climate and of agriculture, Bengal may be said to be divided into three main tracts: (1) Lower Bengal, (2) Behar, and (3) Chota Nagpur and the hilly portions of Orissa. The conditions in the latter tract are in every way widely divergent from those in the rest of the province, and in this article only Lower Bengal and Behar will come under review. Speaking generally, in both these regions the soil is extremely fertile and the rainfall is usually plentiful or sufficient. The cultivation is consequently of an intensive character. In Lower Bengal, where the rainfall is heavy and well distributed over the year, wet crops, such as paddy and jute, are principally grown. In Behar, with a lighter rainfall, paddy is usually confined, except where there is canal irrigation, as in Shahabad, to the lower-lying lands, but a great variety of dry crops is grown, much of the land ordinarily bearing both a kharif and a rabi crop in the same year. The population which is almost wholly agricultural is very dense, often exceeding 1,000 to the square mile.

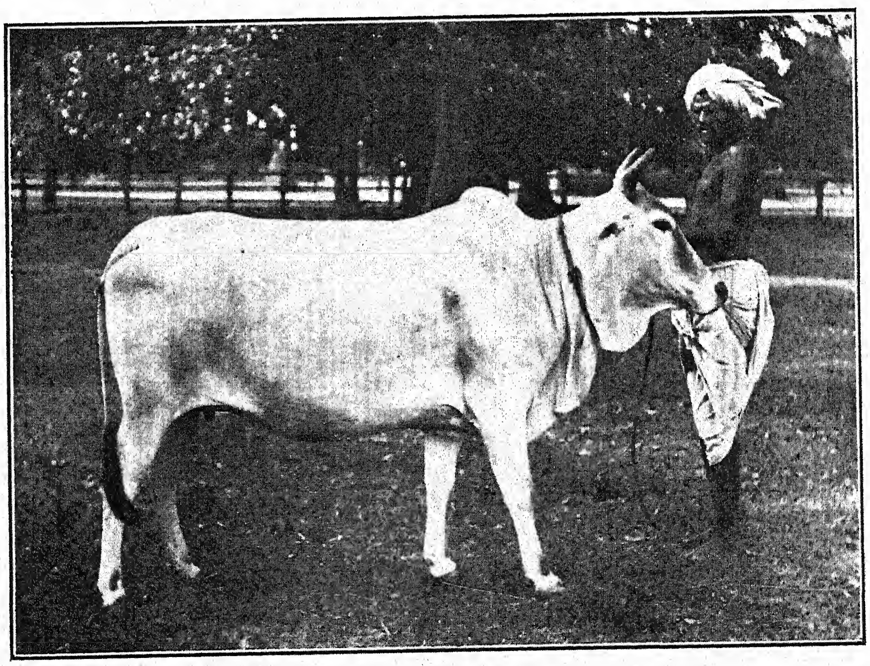
In this country the common experience is, that the quality of the cattle varies inversely with the intensiveness of the cultivation, and hence it is hardly surprising that Bengal cattle are the worst in India. It is almost entirely a question of food supply. For many generations the cattle have been consistently starved, and the result is seen in the degenerate specimens existing to-day. Over the greater portion of the Bengal plains, grazing is very limited. In the Shahabad, North Darbhanga and

North Champaran districts of Behar there are still considerable expanses of waste land, and there some quite good cattle and certainly the best in Bengal are to be found. With the pressure of population these grazing areas are continually being encroached on. In Darbhanga district they are said to have contracted twenty-five per cent. within the last few years, and in Shahabad the opening of the Sone Canal has brought a great deal of what was previously waste land under cultivation. In most of Behar, and still more in Lower Bengal, grazing supplies only an infinitesimal portion of the food required by the enormous numbers of cattle. The remainder is very inadequately supplied from the fodder available from the field crops. In Behar the average cultivator's bullock is a starved, stunted, weedy-looking beast. It is active but quite incapable of hard or prolonged work. The tillage implements are of the lightest character and only the easy working nature of the soil makes decent cultivation at all possible. Even as it is, by better tillage alone, Behar could probably be made to yield fifty per cent. better crops. The cows are worse comparatively than the bullocks, for the latter have the first call on the food supply. They usually yield a negligible quantity of milk, and the young stock, especially the young female stock, are consequently starved from the beginning. In Lower Bengal we find the same state of things, only in a more intensified degree. The cattle are probably of the same stock originally as those in Behar, but they have become still more diminutive and tillage implements have been reduced in size correspondingly.

If, then, we except Shahabad and certain portions of North Behar, where a fair number of moderately good cattle is produced, the condition of the cattle in Bengal could not well be worse. The Bengal Government has recognised the necessity of doing something to remedy this state of affairs, and within the last few years herds of selected cows have been established at Siripur, and by arrangement with the Government of India, at Pusa, for the purpose of breeding bulls of a superior type for distribution in the province. The cows for these herds have been selected by the Bengal Civil Veterinary Department from the Shahabad district

PLATE XXXVII.





A. J. I.

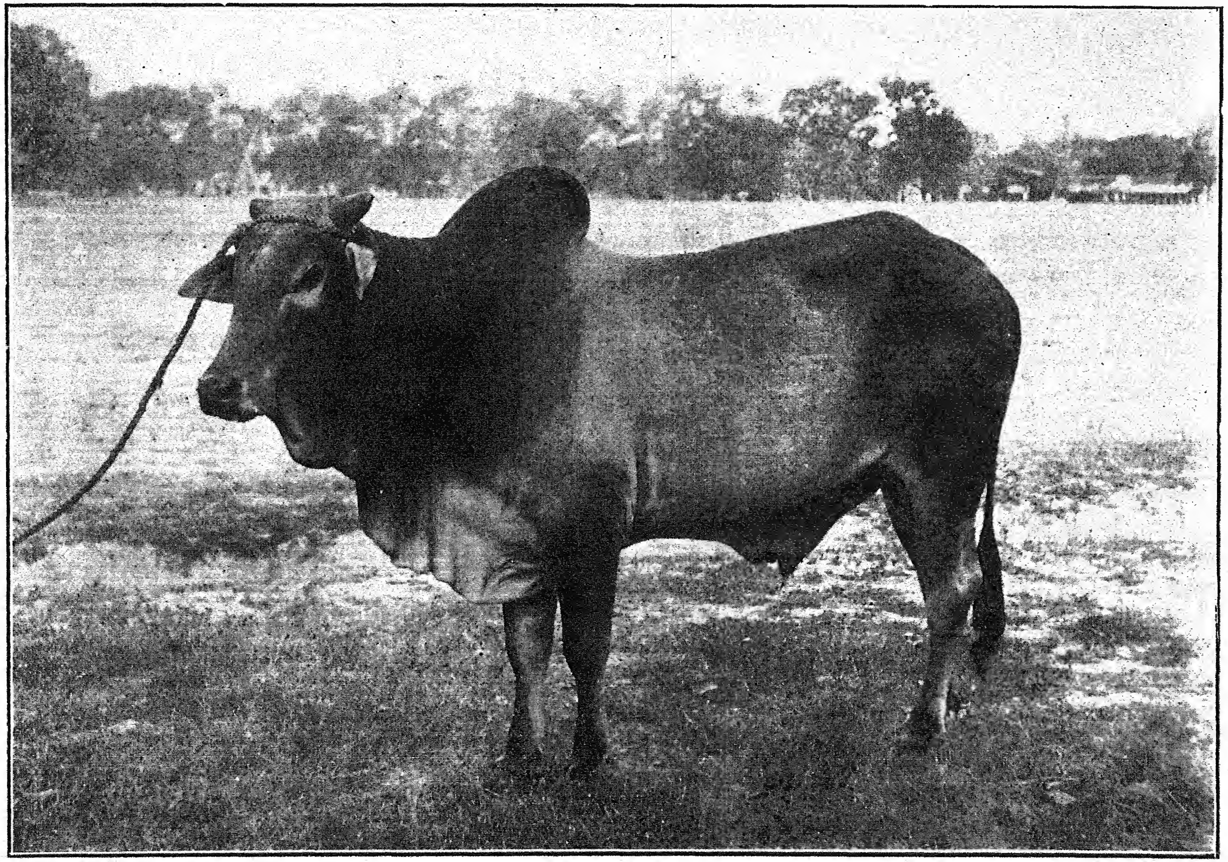
COWS, PUSA HERD.

chiefly. The object is to produce compact, well-built bulls with good bone, but not too large since they will have to mate with small cows. Representative cows and the present stud bull of the Pusa herd are illustrated (Plates XXXVII, XXXVIII). The cows have not been selected for their milking powers. The sole object at present is to produce bulls which will beget better work cattle.

It may be asked how far the method adopted for the improvement of cattle in Bengal is likely to succeed. There is no doubt that there is a great scarcity of good bulls all over the province, and all that Pusa and Siripur can supply will be eagerly sought for. Such bulls also should have a considerable effect in raising the standard of work cattle in the districts which they serve, for the cultivator usually does the best he can by his male young stock. On the other hand, the area of the province is enormous, and at the best, only a comparatively small portion of it can ever be supplied with these better bred bulls. Unless the cultivators can learn the lesson of what can be done by selection and breeding, and themselves carry on the work, little permanent improvement can be looked for. The weakness of the present method of improvement (apart from the impossibility of supplying more than a fraction of the number of bulls required), is that all the attention is being concentrated on the bulls, while no account is being taken of the cows. However good the bulls may be, no good stock can be produced if the cows continue to be starved and neglected as they are now; and there is little doubt that they will continue to be starved and neglected until the cultivator obtains a better cow. The fact is, that at present the average cow is such a wretched specimen that the cultivator cannot afford to feed her better than he does. Practically, the only return which she gives for her feed is her calf, and that is not enough. What he wants is a good milch cow which will not only rear a calf but leave a substantial surplus of milk to her owner. Such a cow he is prepared to pay for and prepared to feed. It is surprising how little more a good milch cow eats than a bad one. She is simply a more efficient animal.

To produce for Bengal a type of cow which will be a good milker, and at the same time breed work cattle of the type required for the province, does not seem to be impossible of realisation. It may take many years, but until such a type is produced, I strongly believe that no substantial or permanent improvement in the cattle will be effected.

PLATE XXXVIII.



A. J. I.

BULL, PUSA HERD.

THE JORHAT AGRICULTURAL AND INDUSTRIAL EXHIBITION, HELD ON 12TH FEBRUARY 1908.

By S. G. HART, I.C.S.,

Director of Agriculture, Eastern Bengal and Assam.

The Jorhat Agricultural and Industrial Exhibition was opened on the 12th February 1908, by Sir L. Hare, Lieutenant-Governor of Eastern Bengal and Assam. It remained open till the 26th idem and drew large crowds of visitors.

The exhibition was held in a temporary building erected on the *maidan* adjoining the Sub-Divisional Offices. A great deal of care had been bestowed on the decoration of the buildings and the laying out of the grounds. At night the whole place was lit up by the 20th Century Light.

All the arrangements of the exhibition were carried out by a local committee, of which the Sub-Divisional Officer was Chairman. The Gossains (high priests) of the Majuli, European planters and all other classes of the community took a large and active interest in the promotion of the exhibition and contributed about Rs. 11,500 of the total cost, the balance of about Rs. 4,500 being contributed by the Local Boards of the district and the Agricultural Department.

The original intention of the promoters of the exhibition was to restrict its scope to the Assam Valley districts. But in consequence of advice and suggestions received from various quarters, and considering that a show limited to Assam Valley might be deficient in educational value and attractiveness, the committee decided to extend its range to include interesting exhibits from outside Assam proper. An exhibition on this scale is the first attempted in the province of Eastern Bengal and Assam. Exhibits were received from almost all the districts of

Eastern Bengal and Assam and also from Manipur, Calcutta, the 24-Parganas, Hooghly, Howrah, Midnapore, Bankura, Cawnpore, Dehra Dun, Kistna (Madras), and Jaipur. The exhibits were arranged in two main groups : (1) Agriculture and Forestry, and (2) Industry.

Agriculture.

Every important crop of Assam was well represented and numerous exhibits of special interest were received from outside the valley.

The Inspector of Schools, Surma Valley, sent in a comprehensive collection of agricultural products of that valley, and there were similar private collections to illustrate the cultivated plants of the Assam Valley.

The Sibsagar Forest Division contributed a representative collection of timbers indigenous to Assam.

The Agricultural Department sent a special exhibit which included cocoons of the European Univoltine silkworm, raised at the Shillong Farm, lemon grass oil from the Government Tropical Plantation at Wahjain, several varieties of American sweet potatoes grown at Shillong, cigars from the Rangpur Experimental Farm and specimens of canned and bottled fruits and vegetables. Another interesting feature of the departmental exhibits was a collection of the more important insect pests illustrated by actual specimens or illustrations, together with samples of various insecticides and appliances for destroying insects. Copies of a printed note (in English and Assamese) on these pests were distributed.

Another collection of injurious and beneficial insects was exhibited by Mr. C. B. Antram, Entomologist of the Indian Tea Association.

Special mention should also be made of several exhibits of exotic rice grown in Assam ; a collection of nearly 400 varieties of paddy exhibited by the Superintendent of the Jorhat Farm ; various specimens of cultivated and wild fibres, among which were Spence's cotton, jute, *mestapat*, Mauritius, sisal and other

agaves, flax, sida, pineapple, rhea, *hibiscus mutabilis* and plantain fibres. Some of the samples of jute exhibited for length, strength and lustre would hardly be surpassed anywhere in Bengal.

The best collections of fibres were exhibited by Mr. Finlow, the Government Fibre Expert, and Babu Mangobind De Choudhury, proprietor of a farm near Silchar.

Of groundnuts, a crop new to the province, a very good sample was exhibited by the same gentleman from Silchar.

A fair collection of agricultural implements of improved types, more or less suited to the circumstances of the country was exhibited, among which the Hindustani plough and the Planet Junior Hand-hoe have been favourably reported on by the Agricultural Department.

Industry.

Textiles were well represented. Besides a large assortment of yarns and of plain cloth woven from cotton, Eri, Muga and Pat (mulberry) silk, there was on view a great array of muslins and embroidered cloths, both from within and outside the Assam Valley. To illustrate an art in which Assamese ladies specially excel, many fine silk and cotton cloths embroidered with silk and gold thread were exhibited, together with the pattern from which they were woven. In these patterns in which thin strips of bamboo take the place of the warp threads, the design of the cloth is given on a magnified scale.

Several exhibits of crocket work deserve mention as showing proficiency in a newly introduced art.

The weaving exhibits included several improved hand looms. Besides the "Triumph Automatic" loom of the Salvation Army, and Mr. Chatterton's adaptation of the Hattersley loom, a loom invented by Babu Mahendra Chandra Nandi of Kalikacha, in Tippera district, was interesting on account of its efficiency combined with low price.

Among the art wares were some fine specimens of silver filigree work from Dacca and Cuttack, ivory work of Jorhat,

Murshidabad and Manipur, models in papier mache, wax and clay of various places, and especially some costly exhibits of gold jewellery with enamel work inlaid – an old art which now survives only in Jorhat town.

The one feature of the show was the number of articles which not long ago were never made in India but entirely imported from abroad. These included soap, candles, leather goods, cutlery, stationery, hosiery, etc., all evidencing an industrial awakening, though only a small proportion came from the Assam Valley.

The inventor of the Kalikacha loom also exhibited an ingenious machine for making matches. It is worked entirely by hand and the total cost is only Rs. 150.

The technical schools of the Province showed some good relief maps, astronomical maps, models, etc., made by pupils.

Earthen-ware roofing tiles (similar to those of Raniganj), manufactured at Itakhola, A. B. Ry., were exhibited by Babu Prakash Chandra Roy and were very favourably reported on.

FURROW IRRIGATION.

By ALBERT HOWARD, M.A., A.R.C.S., F.C.S., F.L.S.,

Imperial Economic Botanist.

One of the first questions that has to be considered in connection with experimental work in the field in India is the best means of applying irrigation water. The present paper is written with the object of recording the writer's experience in this matter at Pusa during the last three years.

The usual methods of watering plants in India are well known and need not be described in detail Where water is abundant, as for example in the Canal Colonies of the Punjab, the surface is divided up into beds (*Kiaris*) and flooded. In well irrigation, in the United Provinces, a similar method is used, except that here the *Kiaris* are much smaller in size. In gardens, basin and trench irrigation are to some extent employed, but it has often appeared to me that much remains to be done in India to improve this latter system of watering.

The disadvantages of flooding the surface are well known. Besides the destruction of the tilth and the formation of a surface skin (*papri*), which becomes hard and impervious on drying, this method leads to a great loss of water by evaporation. Moreover, in many cases, percolation is slow, as the air in the soil can only escape very slowly laterally. Further, flooding the surface often leads to an infertile condition of the soil, due posisibly to the partial destruction of the bacterial flora thereof.

In order to overcome the disadvantages of surface flooding and also to economise water, a method has been devised which combines the advantages of furrow irrigation, basin irrigation and irrigation by lateral seepage and at the same time allows of a proper surface tilth being maintained. The method can be

applied both to orchards and to crops like tobacco, ganja, cotton, patwa, etc. It has been found to be particularly valuable in the case of newly planted fruit trees and for crops like tobacco and ganja, which have to be transplanted in the field from the nursery.

In orchards the method adopted is as follows :—

A trench about a foot wide and four inches deep is laid off parallel to the rows of trees. Each tree is then surrounded by a similar furrow-ring, the position of the ring corresponding to the outer spread of the branches. In newly planted trees the inside diameter of the furrow-ring is from 3 to 4 feet. The rings are joined up to the longitudinal trench by short connecting trenches by means of which the rings can be cut off by an earth fillet from the longitudinal trench. The following diagram will make the arrangement clear :—

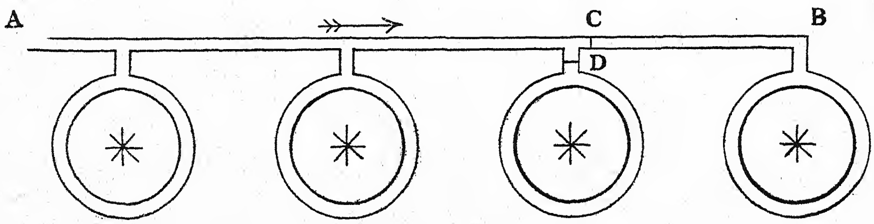


FIG. 1.

In carrying out this system in practice, water is allowed to run down the trench AB to B, the furthest point from the main distributing channels. The last ring is then opened and allowed to fill. As soon as this takes place, the main trench is filled at C with a fillet of earth and the connection at D is opened. The second ring is now filled and so on. In this way there is no stoppage of work and the tree is not only supplied by the water in the ring but also by that in the section of the trench CB.

With young trees the rings are filled up after every monsoon and re-made on a larger scale at the beginning of the next hot weather after weathering and manuring have been done. The longitudinal trenches are left during the monsoon as these serve as drainage channels and prevent local water-logging.

In planting new trees this system of irrigation has been found most useful. After the holes have been dug for the trees and filled in, the rings are made and the irrigation water run into these *before* planting. By this means any shrinkage and subsidence of the soil takes place before planting, and can be adjusted. Moreover, the young trees have the benefit of being planted in a moist soil. February and March are the best months for planting young trees in Behar, and by this means they can be established before the heavy rains of the monsoon in July and August.

In connection with the manuring of trees this system of irrigation has proved most useful. One of the difficulties in applying manure to fruit trees in India is the subsequent damage done by white-ants (*Termites*), which are attracted by the organic matter of the manure and frequently turn their attention to the tree and destroy it. If the trees are manured just before the rings are made, and if care is taken to apply the manure only to the ring of soil just underneath the outside branches, the first watering not only tends to rot the manure but also to drive off the *Termites*.

This ring method has great advantages over the basin method of irrigating fruit trees, which is practised by the cultivators in India. In the basin system (Fig. 2), a shallow circular hole is excavated round the base of the tree, and these basins are connected up by short trenches between the trees.

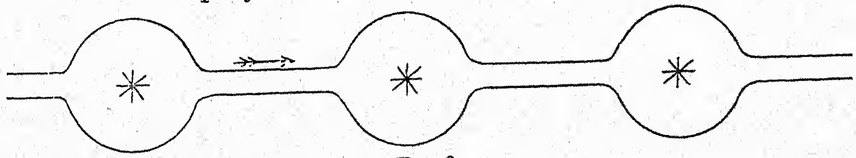


FIG. 2.

In the first place, trees like Citrus plants are not benefited by water lying round the base of the stem and are then often attacked by the "collar rot" disease. Secondly, the water is not applied directly to the young roots of older trees, while in young trees they are apt to be water-logged. Lastly, this method does not facilitate manuring and drainage in the monsoon.

In the case of transplanted crops like tobacco and ganja the system becomes one of modified furrow irrigation. The great danger in growing a crop like tobacco, especially where the autumn rains fail, is the loss of plants which occurs on transplanting them in the field and also from grasshoppers. The usual method in India is to transplant in the evening, to water the young plants and to cover them with *nim* leaves during the heat of the day. Even when every care is taken, many plants die. In plant-breeding work, this loss is of great importance owing to the danger of a dead plant being replaced by one of a wrong variety. In order to minimise this loss, I have devised the following method :—After cultivation and manuring are finished, furrows about one foot wide and four inches deep are laid off at the proper distance, so that there will be a furrow between alternate rows of tobacco.

These furrows are then filled with water several times, and the water is allowed to percolate laterally until the soil is well moistened between the furrows. Transplanting is now carried out in the soil moistened by lateral seepage from the trenches, and the young plants are covered with *nim* leaves during the day which are removed at night. (See Plate XXXIX.) When this method is used, the loss of plants is not more than one per cent., and there is practically no danger of destruction by grasshoppers. During the last year when the failure of the autumn rains almost destroyed the tobacco crop of the cultivators in the district, no difficulty was experienced in growing good tobacco at Pusa. Subsequent irrigation is done by filling the trenches in the same manner as that adopted before transplanting.

PLATE XXXIX.

A. J. I. FURROW IRRIGATION AT PUSA WITH TOBACCO.

NOTES.

Potash Manures.—The February Number of the "Agricultural Gazette" of Tasmania contains an interesting extract from "The Farm and Home" on Potash Manures. The writer points out that potash manures are less understood and favoured, though not actually less important, than nitrogenous and phosphatic manures. The action of potash manures depends very much upon the soil, so that individual experiment is more necessary with this class of manure than with any other. Soils with any clay in their composition generally contain potash, and here the application of potash is seldom followed by any benefit. For with such soils, the application of the ordinary (non-potassic) manures very often sets free the locked-up resources of the soil. Alkaline manures (*e.g.*, those containing lime or soda) decompose the insoluble silicates and liberate potash in an "available" condition. When nitrates are used, the root-system goes deeper in the soil, and thus there is a wider range from whence the plants may extract their food supply.

While nitrogen encourages growth and bulk, and phosphates promote early maturity, the special function of potash is, to some extent, to improve the quality of the crop. With wheat, for instance, the effect of nitrogen and phosphates is to increase the number of grains, but it is left to the potash to secure plumpness and quality in these grains. Crops cultivated for their pods (*e.g.*, groundnut, gram, etc.), or for their leaves (*e.g.*, tobacco, cabbage, etc.) and root-crops valued for their starch (*e.g.*, potato, yam, etc.), are particularly benefited by potash. In the same way with fruit trees; the potash encourages good colour and flavour in the fruits, specially in those which contain sour

juices. In this connection Mr. N. G. Mukerji mentions an interesting case. In the Berhampur Jail, there were hundreds of lime trees which never bore fruit, although they were mature. Application of potash manures was advised and it was rewarded with a large return of fruit in the very same year. In Bengal, the peasants look upon wood ashes as the best manure for bananas. Potash is also a very useful manure for cigar-making tobacco, having some effect in making the cured tobacco burn properly. Then, again, potash strengthens the stems of grasses and of cereal plants, thus enhancing the feeding value of the straw and facilitating the formation of good grain.

Another effect of this manure is its power of rendering plants less susceptible to fungoid diseases, it having been found useful in checking rust in wheat. This is probably because it encourages vigour in the plants. Potash-manured crops continue their growing period later than others which is advantageous with such crops as potatoes. With other crops (barley, for instance), this effect might be disadvantageous.

Three potash manures are ordinarily available, *viz.*, Kainite, Sulphate of Potash and Muriate of Potash. The first comes from the natural deposits in Strassfurt (Germany). It is unnecessary to enter into the details of their application as these manures are not largely used at present in India. Here the commonest form in which Potash is used is in the form of household ashes. Potassium Nitrate and cattle urine are the best Potash manures ordinarily available in India, and the former is generally cheap at ordinary prices.—(J. Sen).

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Uses of Silt in the Madras Presidency.—In the Madras Presidency, cultivators are well aware of the value of silt as a manure. Large quantities of silt are dug out of tankbeds every year and carted to the fields. In some parts, the right of clearing silt from the irrigation canals is put up to auction, and the silt thus bought is put on to rice lands as manure. The cost of carting is considerable. In dry lands, silt from tanks and other

sources is largely used as manure for top dressing. It is also used to improve saline and badly drained low-lying lands. The silt of some rivers in the Punjab as well as in Madras is considered to be more valuable as manure than that of other rivers.

Owing to the greater manurial value of the silt contained in the red water drained from the Western Ghats, the ryots of the Krishna Delta prefer it for irrigation to that of the grey water drained from the Eastern hills. The first flood of any river in India is held to contain silt of greater manurial value than later in the season, as it carries down all the decayed vegetable matter accumulated on the soil during preceding many months or so. Unfortunately, on account of the denuded conditions of the hills, the silt brought down by many of the rivers consists of coarse sand and light gravel and is useless as a fertilizing agent.

There is a project for constructing reservoirs on the Krishna, the Tungabhadra and the Cauvery, and it is expected that these reservoirs will form great silt traps. The value of silt as manure is being tested at the Hagari Experimental Farm, and the result will, no doubt, be very useful to cultivators.

Reclamation of waste lands by silt deposit does not appear to have been tried in the Presidency on any extensive scale. There is ample room for such trials on the waste lands on the Malabar Coast and elsewhere.—(EDITOR).

* * *

THE SOLAR MOTOR.—Recently a novel machine, known by the name of Solar Motor and worked by the heat of the sun's rays, for raising water for irrigation, is claiming attention chiefly in the United States of America. It is a steam engine driven by the concentrated rays of the sun. It consists of a reflector and a boiler. The reflector is in the form of a truncated cone 35 feet in diameter across the top and 17 feet at the bottom. It intercepts about 1,000 square feet of sunshine and reflects it on the boiler which is a copper tube about nine feet long and twelve inches in diameter. It is rigidly fixed in the centre of

the reflector and revolves with it. The reflector swings round and follows the sun as a result of a simple clock-work device. The boiler supplies steam at a pressure of 150 lbs. per square inch to a steam pump. Both reflector and boiler are mounted on supports.

It is said that the whole machinery works almost automatically. All that is required is to focus the reflector in the morning and start the clock work. It takes about one hour to raise the steam. The power for work depends upon the time the sun is above the horizon.

A Solar Motor of ten-horse-power engine capacity can lift about 1,400 gallons of water per minute from a depth of 12 feet. It costs in America £400 or Rs. 6,000. These Solar Motors are chiefly used at present to work pumps for irrigating the dry lands in California, where one motor suffices to irrigate from 150 to 400 acres of land according to the kind of the crops The farmers pay from £2 to £3 an acre for such irrigation.

To set up a ten horse-power Solar Motor in India, the cost will probably be over Rs. 10,000. Allowing 4 per cent. interest, 10 per cent. depreciation, 5 per cent. for repairs and Rs. 360 a year for maintenance, the total working expenses will come to about Rs. 2,260 a year. The Solar Motor in India would not be of extensive practical use, unless it lifted water 30 or 35 feet from rivers, lakes or tanks. The ten horse-power motor, with depth to water 35 feet, would not irrigate a larger area than 100 acres of perennial crops or perhaps 200 acres of mixed crops, sown at different seasons in succession, each of which takes four or five months to mature. The approximate cost per acre for irrigating perennial and ordinary crops will therefore be Rs. 22-8-0 and Rs. 11-4-0 respectively.

These charges are, no doubt, small when we know that in Bombay Presidency it costs a good deal more to irrigate fields with well-water lifted by ordinary country appliances. It is very doubtful if Solar Motors can be economically used for well irrigation in India, as in average years the water of a well is ordinarily sufficient for only 3 or 4 acres in Peninsular India and

for 20 acres or less in the United Provinces and the Punjab. A Solar Motor can possibly be economically used in lifting water from large tanks or other reservoirs or from perennial rivers and streams. Even in the case of reservoirs, a Solar Motor will only be useful for brief periods when the water gets low. It will be of no use for a considerable portion of the year when the flow is usually by gravitation. In the case of rivers, it would be cheaper, where possible, to irrigate by flow through a canal system. Along deep banked slow running streams, there are, however, numerous positions where considerable areas could be irrigated by raising water 30 or 35 feet.

Besides the limitation imposed by the supply of water, there is another condition, *viz.*, the supply of sunshine which considerably restricts the use of the Solar Motor in India. There is little sunshine during the rains when most of the irrigated crops are grown. In Northern India the hot season is not suitable for the growth of any but one or two special crops. In winter the sun is not hot enough for a Solar Motor to work successfully. In Madras the Solar Motor will stand no chance against the oil engine, because the capital cost of the latter is only a quarter of that of the former and the fuel charges are not high. Moreover, the Solar Motor is not at all likely to prove of use to the Indian cultivator as it requires skilful adjustment, delicate handling and skilled labour to repair.

A Solar Motor, based on the action of the unconcentrated rays of the sun, has recently been invented in America. By storing power in hot water, this motor has been worked night and day. The whole plant is entirely automatic. The total cost is as follows :—

	£
Cost of sun heat absorber 20′ × 20′	30
Cost of storage tank for hot water	5
Cost of turbine condenser and pumps required for handling the condensed water	50
Cost of freight in erection in India	50
Total ...	135

This does not include the cost of a pump required to lift the water from a reservoir or river.—(EDITOR).

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PUNJABI REAPING-HOOKS.—It has frequently been observed that the cultivators of the various agricultural tracts of India have much to learn from each other in the details of agricultural practice, and that much good can be done by introducing into a district some practice adopted in other parts of India. The writer has been impressed with the need of further work in this direction and ventures to bring this note forward as a minor example of what is meant.

In the Canal Colonies of the Punjab labour is scarce and dear at harvest time, and part of the wheat crop has to remain standing on the ground for some time after it is ripe for the want of reapers. So great is the demand for labourers that European labour-saving devices, such as reaping machines, are being tried and will probably be adopted widely. The method of the people in reaping is very much the same here as in other parts of India. The crop is cut by hand by means of a small reaping-hook (*hanswa*). The intermediate method of mowing by scythes does not seem to be practised and is probably too laborious for adoption in India where the labourer loves to squat and occasionally have a rest. I have never seen mowing done in India as it used to be done in England before the adoption of reapers and self-binders.

In the wheat harvest of 1907 my attention was arrested by the comparatively greater efficiency of the reaping sickle of the Punjabi peasants over that used in Behar. A sample was taken to Pusa and this year placed in the hands of a *Kœri* cultivator employed in the Pusa Botanical Gardens. He was able to reap much faster with this than with his own tool and was much impressed with its advantages over the local sickle. Accordingly, a supply of copies was made in the local bazaar from the original brought from Lyallpur in 1907. The local reaping sickle is

shown in Fig. 3 A, while B & C illustrate the ones in use in the Punjab.

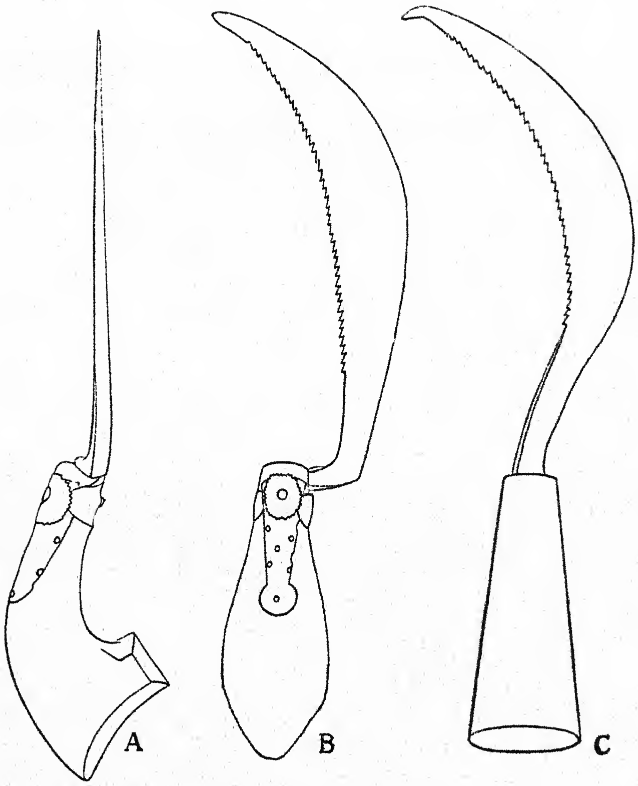

FIG. 3. REAPING-HOOKS.

The advantages of the Punjabi hook are to be found in the protection given to the hand by the curved handle and in the more scimitar curve in the blade. The price of the Behar sickle is said to be $1\frac{1}{2}$ annas, while the one brought from Lyallpur cost me four annas. I have, however, not been able to ascertain what the local price for these articles usually is among the people themselves. The prices given are no doubt only of comparative value.—(A. HOWARD).

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THE PLANTING OF DURANTA HEDGES.—During the recent meeting of the Board of Agriculture at Pusa, February 1908,

several inquiries were made by Members as to the method adopted in raising the *Duranta* hedges in the Botanical Gardens at Pusa. The present note has been written for the purpose of placing the writer's experience in this matter on record.

The best hedge plant for use in Behar is at present undoubtedly *Duranta plumieri*, Jacq, and very good hedges of this species are to be frequently seen at the stations of the Bengal North-Western Railway and in many private gardens.

The best of the methods tried at Pusa for raising good, even hedges of this plant is as follows :—

At the end of February, beds of cuttings taken from the mature wood are laid down in well-shaded nurseries, and at the same time the site of the future hedge is determined and the soil dug out to a depth of three feet and left on the edge of the trench. In this way the soil becomes well aerated during the hot weather, and better results and a more even hedge were obtained by a previous preparation of this sort than by copious manuring even when assisted by a preliminary cultivation with the *Kodali* before planting.

Towards the end of the hot weather the trench is filled up and the earth allowed to consolidate and moisten during the early rains. When the soil is moist enough and subsidence has taken place, the rooted cuttings in the nursery are cut back, taken up with balls of earth and firmly planted out. At first they are covered with grass to shade them till new shoots begin to appear through the covering, when the grass is removed and the surface broken round the *Duranta* plants with a *Kurpi*. The *papri* (the surface skin on the soil produced by heavy rain or irrigation) is kept broken up from time to time during the monsoon and the hedge is kept free from weeds and grass, and any dead plants are replaced from the nursery. The young plants are kept cropped with shears and the hedge is allowed to grow up slowly and evenly. The preliminary cutting back on planting and the cropping with the shears produce abundant lateral shoots, and a thick-set, even hedge results.

The time of planting, however, is not of very great importance, provided the preliminary cultivation has been done in the manner indicated and provided rooted cuttings are available and also artificial irrigation. Very good hedges have been obtained by planting after the monsoon in October and also during the hot weather in May. In such cases, however, watering is essential.—(A. HOWARD).

* * *

A GOOD SCREENING PLANT.—In the laying out of new compounds and in the building of new stations it is often desirable to screen off unsightly buildings and to separate one compound from another as quickly as possible. For this purpose a rapidly growing plant is necessary which at the same time can be kept in bounds and is not unsightly. For this purpose *Sesbania ægyptiaca*, Pers., is of considerable value. A thick hedge of this plant can be grown from seed 7 or 8 feet high in one year. Moreover, it can be cropped and kept neat during this period. Permanent hedges of *Duranta*, *Dodonea* or *Inga* can at the same time be planted parallel with the temporary *Sesbania* which can be removed when the permanent hedges are high enough. *Sesbania ægyptiaca*, Pers., is also useful as a temporary wind-break on exposed land.—(A. HOWARD).

* * *

THE SETTING OF PLUMS IN BEHAR.—Although various varieties of plums grow freely in Behar, nevertheless it sometimes happens that the trees fail to set fruit although there may be a copious blossom. Nearly all the varieties of plums at Pusa flowered heavily this year although the trees are very young. Only a few, however, set fruit, and in these cases the trees have had to be thinned to prevent the branches being broken by the weight of the crop. The contrast between the trees which set fruit and those which merely blossomed was very great. It was noticed that in all cases the early flowering varieties set fruit, while the late flowering varieties dropped their blossoms as soon as they opened. The result is probably due to the hot west winds which

began early this year, and experiments have been arranged at Pusa to see whether by judicious irrigation the fruit on the later flowering varieties can be made to set. In the meantime it appears desirable to suggest that the early varieties are the best to grow in Behar.—(A. HOWARD).

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TREE COTTON EXPERIMENTS IN BENGAL.—The experiments with perennial cottons undertaken by the Indian Long Stapled Cotton Growing Syndicate (Agents, Messrs. Shaw, Wallace & Co., Calcutta) have not proved the suitability of Behar to such cottons. The principal plantations at Maniarpur were twice (1905 and 1906) severely damaged by floods. The liability to flood of most of the parts of Behar makes them, in the first place, unsuited to the cultivation of tree cottons which are very susceptible to damage from excessive moisture. The firm consequently transferred in 1907 their operations to Mourbhanj (Orissa District) where a small plot of ground grown with tree cotton had given some promise of success. The total area planted at this place measures 230 acres. On this area are grown five or six varieties of perennial cottons of both Kidney and Naked seed types. These have been sown in different ways, *viz.*, on ridges, on mounds, on the flat, etc. Messrs. Shaw, Wallace & Co. may be congratulated on persevering with the cultivation of tree cottons on an extensive scale and in the face of many difficulties, the more so particularly as in many parts of India the experiments which have been carried out during recent years have mostly resulted in failure.

The firm recently sent to the British Cotton Growing Association, Manchester, two bales of lint of tree cotton, grown by them at various centres. The lint comprised some seven varieties of both Kidney and Naked seed types. The lint of most of these varieties was reported by the Association to be of very little value, being short in staple, full of crushed seed and stain, and immature. The best sample was valued at $10\frac{1}{2}d.$ per lb. —(EDITOR).

Cultivation of Caravonica Cotton in India.—About four years ago Dr. Thomatis professed to have evolved, by methods speedy enough to be accepted as magic, three remarkable varieties of tree cottons, the excellences of which he briefly summarised as follows:—"The tree cotton will require only one planting, will necessitate but simple and inexpensive culture, will live probably a man's lifetime, will withstand and defy roaring floods and resist parching droughts, once in full vigour, size and growth. Its proportion of lint I am raising every year; it is now already 40 to 50 per cent. and will steadily increase every year, probably up to a seedless crop." He also claimed to have improved the percentage of clean cotton in the Kidney seed variety from 26 to 40, and stated further that it is a very hardy tree and a heavy and sure cropper in all kinds of seasons. This is entirely opposed to our experience of the plant in India, where it is delicate and a notoriously poor yielder.

In 1905, he wrote to the *Ceylon Observer* as follows:—"You will notice how well I succeeded in disintegrating or loosening the kidney-shaped group of seeds in the Kidney cotton, thus making ginning more practicable. I also succeeded in enlarging the size of the boll and in improving the staple altogether."

I have found, from personal observation of the plants in Poona, that the seeds are certainly loosened to some extent in the majority of examples, but, on the other hand, they are disposed to coalesce in smaller groups, and this feature, looking at it from the ginner's point of view, is probably just as objectionable. He further states that it took three years to educate the trees but, unfortunately, he does not divulge his educational method.

In other communications to the Indian press he reiterates his statements regarding the superexcellence of his cottons. He professed to have no doubt whatever that the *sandy* delta of the Ganges and many river flats or beds and the extensive sea-shores can be made a prosperous home for his wondrous productions!

An article by a botanical expert in the *Madras Mail*, some time in 1905, is particularly valuable, as it gave clearly and

sensibly valid reasons why the pretensions of Dr. Thomatis should not be supported, and it deserves to be quoted at some length.

After briefly dwelling on the failures experienced in the attempts to introduce exotic cottons into India, the article winds up with the following pertinent conclusions :—" Dr. Thomatis has said he expects to produce an almost seedless crop. It would be interesting to know how he has been improving his percentages of lint and, at the same time, been working to obtain a seedless variety. The two results are diametrically opposed to nature......... The cotton plant produces its fibre or lint on the seed itself and to produce a seedless cotton plant for the purposes of cotton growing is as easy of accomplishment as to produce or grow feathers without birds."

Dr. Thomatis, in 1904, said —" Three years ago I collected scores of varieties of seed from all parts of the world, got samples of bolls and lint thereof and then chose two, both of the 'Sea Island' variety......... I crossed them by hybridisation "

" To have obtained seed from all parts of the world, to have grown them to a flowering stage, to have hybridised and obtained seeds from these and to have raised plants from this seed capable of producing cotton, must have taken some considerable time, and when we remember that it was not until 1901 that Dr. Thomatis sent to different parts of the world to collect his seed, we may judge with how much authority he can speak of its habits and requirements, especially for Indian cultivation."

Now that we understand how the evolution of the Caravonica cottons was effected, we pass on to the relation of some actual experiences in the cultivation of these products in India itself. At Poona, in 1905, seeds of Caravonica No. 1 were received through the Inspector-General of Agriculture. Twenty-five were sown ; of these, 12 only germinated and 10 plants were finally put out in good soil in a situation, sheltered but not shaded. After two years, only one plant had survived and that has yielded nothing. The principal characteristic of this variety was its extremely low vitality.

Thirty seeds of Caravonica No. 2, received at the same time, produced 15 plants which were put out in the same area as the above. In two years the individual variations of these were remarkable ; the best was a plant with a height and spread of about 7 feet, three more had attained about half these dimensions and the remainder, weak and stunted all through, died off one after another.

Four plants only yielded cotton in the second year.

Plant No. 1—the largest was so brittle that some of its branches broke down merely with their own weight and others snapped during the prevalence of winds which were never more than moderate in the sheltered plot occupied by the plants.

In 1907, or in the second season of growth, this plant bore 21 ounces of seed cotton, producing 12 ounces of ginned cotton. This works out to a percentage of 57 which is extremely high of course, but is explained by the fact that every seed had been completely destroyed by insects. It would be interesting to know if Dr. Thomatis expects to arrive at his seedless variety by the same method. At the end of the season, the plant, which was in a severely crippled condition, was pruned back according to Dr. Thomatis' recommendation but, unfortunately, it died after the operation.

Plant No. 2 –yielded 7 ounces of seed cotton and 2½ ounces of clean cotton.

Plant No. 3—yielded 10 ounces of seed cotton and 5 ounces of clean cotton.

Plant No. 4—yielded 2 ounces of seed cotton.

The bolls and seeds of all were severely attacked by insects.

Two years ago I examined Caravonica plants on the Nagpur and Bellary farms, and found that they were all of the common stunted type. The only plant I have seen in any way answering to the glowing description of Dr. Thomatis was the plant No. 1 described above, and that was too brittle to retain its branches even in a sheltered position. Further experiments have assisted to prove the low germinating power of the seeds and the extraordinary diversity of the resulting plants. This latter character

is, of course, due to the recent hybrid origin of Dr. Thomatis' varieties. For his own reputation alone, he should have fixed his types properly before selling the seeds at such high figures.

Mr. R. C. Wood, Deputy Director of Agriculture, Northern Division, Madras, has written an interesting report on experiments with Caravonica cotton in Cuddapah.

The seed, obtained by a Bombay Syndicate direct from Dr. Thomatis, was said to be of poor quality and the percentage of germination was very low. Mr. Wood found that, although "Silk" cotton had been stipulated for all three varieties, *silk*, *wool* and *kidney* were to be found. The plants produced (as would be expected from a hybrid) were of many and varied types, in growth, habit and quality.

In this report, Mr. Wood repeats an often urged warning by pointing out the extreme danger perennial cottons have to face from insect attacks. Being perennial, they naturally afford food and shelter to pests which are carried on from one year to another and, in the event of the extension of tree cotton cultivation, which, however, is scarcely a possible contingency, there is always the chance of indigenous varieties in the vicinity being attacked.

In conclusion, I think it ought to be emphasized repeatedly and widely that cultivation, on a large scale, of perennial cottons—whether American, Australian or otherwise—should never be attempted in India.

Their very structure is that of denizens of wooded and sheltered localities; their brittle nature forbids their being grown in open fields exposed to winds; their naked seeds are the easy prey of every noxious insect that exists on cotton, and finally, the reasons which will perhaps appeal most strongly to the commercial world are, they never produce a full crop till the second year, the chances of absolute failure from climatic causes are carried on from year to year, the land becomes weed-infested, and the yield is never commensurate with the area that each individual plant covers.—(G. A. GAMMIE).

Tobacco in South Canara.—Three varieties of tobacco are cultivated as a second crop after paddy in South Canara. The chief centre of cultivation is Kasargod and the three varieties cultivated are—

(1) *Neranki*, (2) *Natti* and (3) *Battayi*. *Neranki* corresponds to what is known in the Tamil districts as *Erumai kappal* (literally meaning buffalo boat) being characterised by long, broad and thick leaf. It is known to be more intoxicating when chewed than the other varieties. Water should be drunk when such effect is experienced. *Neranki* is darker green, more productive and hardy than the other varieties.

Natti corresponds to what is known in Tamil districts as *Oosi kappal* (literally needle boat). The leaf is long and narrow.

Battayi has a leaf of medium size, apparently corresponding to what is known in the Coimbatore district as *Vatta kappal* (literally round boat). It is comparatively bitter or acrid to the taste.

Tobacco is chiefly grown for chewing and to some extent for making snuff.

Soil.—Though sandy soil is generally unsuitable for growing tobacco owing to its marked deficiency in potash, this class of soil on the sea coast in South Canara, especially in the Kasargod Taluk, is successfully cultivated with this crop, with the aid of fish and cattle manures. Strange to say, tobacco is not cultivated in the neighbouring sea-board of the Malabar district.

Omitting the points of cultivation which are the same as in other districts, I shall only mention the peculiar features of tobacco cultivation in South Canara.

The planting is done about the end of October. The seedlings are planted $3\frac{1}{2}$ feet apart between the rows and $1\frac{1}{4}$ feet in the rows and rarely $3\frac{1}{2}$ feet apart both ways.

In another note, particulars of the application of fish manure have been given. When the crop is about two months old, cattle manure is applied at the rate of one head-load to 50 plants. This cattle manure is dark in colour, is well decayed and has a high smell when applied to the land.

The crop is watered daily, generally by pots by hand. The ryots were of opinion that unless the crop were so watered, the drying of the moisture of the dew on the plant would make the leaf bitter or acrid.

To prevent insect pests, 1 *Kudithi* of paddy-husk charcoal mixed with the droppings of sheep is applied to each plant.

One very remarkable feature in the tobacco cultivation of South Canara is the use of a coil made of the grass called *mulihullu,* which is yet to be botanically identified, round each plant. The coil is called in Telugu *Muli theirya.* It is intended primarily to protect the young plant from the sun. On one side the coil is expanded so as to form a broad hood. In the morning the hood of the coil is on the east side of the plant and in the afternoon the coil is turned so as to bring the hood on the west side of the plant in order to shade it.

The coil was observed also to protect the soil moisture from evaporation, in the case of very young crops, as the coil then lay on the soil. When the plant grows taller, the coil is gradually raised on the stem and eventually the function of the coil is reduced to supporting the leaves at the base and preventing them from falling.

When the crop is three months old, it is topped. In consequence of this operation the plants put forth suckers. These are removed. The crop is cut when four months old.

One hundred plants when cured fetch Rs. 3 to Rs. 5. An acre generally carries about 9,000 plants. But only $\frac{1}{4}$ to $\frac{1}{2}$ acre is at the most cultivated by an individual ryot.—(C. K. Subba Rao).

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Fish Manure in Madras.—At Azhikkal, I was informed by a sea-customs officer and ryots that some of the fish caught at distances of 10 or 15 miles from the shore, sometimes were landed in a semi-decomposed condition, and being unfit for human consumption, were sold for manure at Rs. 25 per ton for application to cocoanut trees. Large quantities of such manure were exported, I was told, to Colombo and Japan from Tellicherry

and Cannanore. It is only in sea-side villages that fish manure is applied to cocoanut trees. The application is said to be attended with a remarkable increase in the production of fruit. The manure is buried near the trees in small heaps.

In a tobacco garden at Kasargod, I saw a canoe or small boat full of a jelly-like liquid. I was told to my surprise on enquiry that it was fish manure prepared by boiling sardines (*Malayalam matti, Canarese butayi* or baigay) at the rate of one basketful of fish, worth about 2 annas, in 10 gallons of water. There was not the slightest stench. Another kind of fish commonly used as manure for tobacco in Kasargod is what is called in Malayalam, *Ayilya.* The jelly prepared out of one basketful of fish is applied to 150 tobacco plants at the rate of 2 cocoanut shellfuls to each plant, the plants being $3\frac{1}{2} \times 1\frac{1}{4}$ feet apart. One basketful of fish manure is thus applied to about 656 square feet.

Fish manure is thus applied when the tobacco crop is one month old, a second time 15 days afterwards, and twice more at intervals of 20 days. About 266 basketfuls of fish manure worth about Rs. 33 are applied to an acre of tobacco crop in Kasargod.

Elsewhere in the Madras Presidency putrid fish is known in a few places to stimulate the production of grapes abundantly.

Fish manure is applied on the West Coast not only to cocoanuts and tobacco but also to cucumber, water melons, and valuable kitchen garden crops.—(C. K. SUBBA RAO).

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THE NENDRUM PLANTAIN OF THE MADRAS WEST COAST.—This variety occupies large areas in Malabar and produces fruit of very fine flavour. It is especially the well-developed, unripe fruit which is most in demand. The unripe fruit is cut transversely into a number of thin pieces, salted and fried in cocoanut oil. This forms a delicious curry called *Upperi* which is exposed for sale in large quantities in every big village in the district. Even the green rind or peel of the fruit is fried in cocoanut oil and

eaten. The ripe fruit is used for making *payasam* or sweet gruel and various other preparations. The young suckers are also used as food. The roots and outer sheaths are removed from them. They are then shredded into small bits, washed with water and boiled with the addition of salt.

The best conditions for successful cultivation are as under :—

Soil.—Red gravelly soil is the best.

Season.—Suckers should be planted in the months of *Tula* and *Vricchikam* (November and December).

Preparation of land.—The land is generally ploughed twice. Pits one foot cube are then dug about 6 feet apart. On high land manure is applied immediately before planting. On low land, no manure is then applied. To dry land ashes are applied at the rate of one cart-load worth $3\frac{1}{2}$ or 4 rupees for 150 pits. Over the ashes, paddy and stubble called in Malayalam *odoo* is put, and over the stubble the earth removed in digging the pits is so put that there may be a dish-like depression at the top for holding water.

On low or wet land, ashes, paddy, stubble and earth are put in pits one and a half months after planting. On high or dry land, the plantains are watered daily and on wet land every alternate day. In the third month after planting manure is applied for the second time as follows :—

First, a mixture of cattle dung and ashes is applied at the rate of 50 baskets for 100 plants, a basketful of dung costing 8 pies. Over the manure leaves of various kinds of trees, *viz.*, *kavi* (*Acronychia laudigolia*), nux vomica, mango, *pullenj* (*Phyllanthus reticulatus*), etc., are applied, and over the whole, earth is put as before. In the fifth month, a third application of a mixture of dung and ashes overlaid with leaf manure and earth is made as before, the quantity of manure being half as much again. To high or dry land even a fourth application of the same manure is made about two months afterwards. Parallel drains about 6 feet apart, 1 foot wide and $1\frac{1}{2}$ feet deep are opened for draining the land. After each manuring, the land is deeply hoed or hand dug.

Irrigation is generally necessary from January to May In the eighth month bunches are put forth. The fruit is ripe in the eleventh month. Each bunch contains about 25 fruits. A hundred fruits fetch 10 annas to one rupee.

Each tree puts forth on the average 8 suckers. The price of suckers for planting purposes is 1 to 1½ rupees per 100.

The stems of Nendrum plantain are utilized at present for the extraction of fibre. It yields fairly good fibre.

The total money return from the 1,200 and odd trees which occupy an acre is about Rs. 300, of which Rs. 100 covers the expenses and Rs. 100 is paid as rent to the landlord who pays assessment, the net maximum of profit is about Rs. 100 per acre.—(C. K. SUBBA RAO.)

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THE VALUE OF INDIAN CATTLE FOR EXPORT.—In the *Orange Judd Farmer*, Mr. T. M. O'Connor has published an interesting account of the value of Indian cattle in Southern Texas. It is claimed for them, among other things, that they are immune from ticks, cross well with local cattle and are very hardy. It is not clear from Mr. O'Connor's account which Indian breed or breeds he refers to, but during the past few years there has been a growing demand for Indian cattle of good class for export. Fairly large numbers of Gujerat and Nellore cattle—cows as well as bulls—have been exported at very remunerative prices to breed work cattle suitable for other tropical and sub-tropical countries. The West Indies and South America have indented to a very considerable extent on India for such cattle. Now that a demand for Indian cattle has been established, both in America and other countries, the cattle-breeders in India should do their best to encourage this trade by improving Indian breeds. The high prices paid in recent years for exported cattle must encourage breeders to improve the general character of their stock by better feeding and better management. Thus, somewhat indirectly the general cultivation in India will also be improved by greater tillage power.—(EDITOR.)

Sind Egyptian Cotton.—A lecture on this subject was delivered by Professor Shahani of the Sind College, Karachi, at a Meeting of the British Empire League. It is interesting as showing the results obtained by a zamindar cultivating this crop under the ordinary circumstances obtaining in Sind. His yearly yields were as follows :—

Year.	Variety.	Area in acres.	Yield per acre.	Remarks.
1904	Mit-Afifi ...	$4\frac{3}{4}$	$1\frac{1}{4}$ acres at $9\frac{1}{2}$ mds. seed ; cotton $3\frac{1}{2}$ acres at $4\frac{1}{4}$ mds. seed cotton.	The first portion was sown in March and more or less cultivated after Egyptian methods. Second portion broadcasted on flat without hoeing or thinning.
1905	Mit-Afifi ...	153	Mit-Afifi $7\frac{3}{4}$ mds. seed cotton.	Water-supply deficient ; cultivation not so close to Egyptian standard.
,,	Abassi ...	52	Abassi $6\frac{1}{4}$ mds. seed cotton.	
1906	Abassi ...	505	4 maunds ...	Bad attack of bollworm.
1907	Abassi ...	275	Average 5 to 6 maunds.	Mit-Afifi distinctly more vigorous in growth.
,,	Mit-Afifi ...	300		

These figures present several interesting points which might be summarised as follows :—

I. The closer the approximation to Egyptian cultivation, the better the crop. A number of cultivators simply plough the land once, then sow the seed, give a rough harrowing and irrigate. With treatment like this it is absurd to expect good crops, especially as much of the land is alkali.

II. Mit-Afifi is a more vigorous variety than Abassi. The former did not, however, take well with the buyers on account of its brown colour. So the cultivator got a price below its real value.

III. The yields are poor, and by these figures, hardly as profitable as growing the local Sindhi cotton. The latter would probably average on similar land 12 maunds per acre and be worth from Rs. 5-8-0 to Rs. 6-0-0 per maund of seed cotton. The produce of 1907 Mit-Afifi was graded in Alexandria as above "Fully Good Fair ;" the Abassi was not classed. Both were worth at present prices between 8*d.*—9*d.* per lb. Egyptian cotton to pay well should not yield less than 10 maunds per acre.

Professor Shahani's greatest difficulties in the way of cultivation were want of water and labour and bollworm attack; he is, however, hopeful that all these may be overcome.

The conclusion forced on any practical observer is that before the cultivation of Egyptian cotton can be put on a firm basis and extended, the standard of cultivation must be vastly improved. And also the causes which underlie this want of system must be remedied.—(G. S. Henderson).

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West Indian Agricultural Conference, 1907 (West Indian Bulletin, Vol. VIII, Nos. 1 and 2).—Representatives of the Imperial Department of Agriculture and of the various Island departments met in Jamaica in January 1907 under the presidency of Sir Daniel Morris, Imperial Commissioner of Agriculture for the West Indies. The method of the Conference is, for a comparatively limited and, on the whole, agriculturally homogeneous area like the West Indies, an excellent one. Representatives contributed papers—nearly thirty altogether—showing the lines of work on, and the present position of, the principal agricultural industries of their respective islands. Thus, the Conference at once provides an opportunity for meeting for an exchange of ideas and affords the material for a conspectus of the agricultural position of the West Indies as a whole. The Sugar industry remains the most important in the islands, and it is satisfactory to learn that its prospects have much improved within the last few years. The Sugar Convention has resulted in higher prices being obtained in European markets, and at the same time the Canadian tariff, with its preference for British-grown sugar, has opened up a large new market in Canada, three-fourths of the total production of sugar in the West Indies now finding its way there. Sugar-cane diseases, which were such a serious factor in the industry, have been largely brought under control, chiefly by the production of new seedling varieties more immune to disease and, in the case of the best of them, yielding more sugar. The most important need now is said to be the lowering of

the cost of production by improvements in cultivation and manufacture.

Cacao is the second most important industry of the West Indies. Here, again, disease has given a great deal of trouble. Starting with the better varieties, planters have been compelled to abandon them for the low grade hardier sorts, and the quality of the West Indian Cacao on the market has greatly deteriorated. Improvement by seed selection from superior trees is made difficult because of the natural habit of the trees to cross-fertilize. The agricultural departments have, however, shown that improvement can be effected by means of budding and grafting, and they recommend this as a practical method. Recent manurial experiments with Cacao have given gratifying results as regards both yield and resistance to disease. The most successful manure is also the cheapest and most generally available—*viz.*, mulching with grass and leaves.

The annual value of fruit—mainly bananas, oranges and grapes, exported from the West Indies, is nearly one million sterling The great obstacle to expansion of this trade is the difficulty of transport to Europe at reasonable rates. Attention is for the present being concentrated on better methods of handling and packing rather than on the extension of the area under fruit.

Success continues to attend the growing of Sea Island cotton. Introduced experimentally in 1900, by 1906 it occupied an area of 15,000 acres. The yields have been good and the quality of the lint excellent (in 1907 some of the lint fetched as much as thirty pence per pound). The high prices which have ruled for the best qualities of lint owing to shortage in the United States have been mainly responsible for the rapid extension of the area under cotton. Insect pests give a good deal of trouble and are costly to check, and it is pointed out that for this reason and also because unfavourable seasons must be reckoned with, the average of the prices of the last three years must be maintained if the industry is to be established on a firm basis.

In common with other tropical countries, the West Indies is devoting a good deal of attention to the cultivation of rubber.

A good many plantations are in existence and such little tapping as has so far been done has given good results. The fact that Estates on which rubber has been planted have risen greatly in value shows that a successful future is anticipated for the rubber industry. The varieties most in favour for planting are Castilloa Para and West African rubber (*Funtumia elastica*), but several other varieties are also being tried.

These are the most important subjects discussed at the Conference. The Agricultural Departments are evidently in close touch with the agricultural problems of the Islands and are doing useful work. It is satisfactory to learn that the existence of the Imperial Department of Agriculture which under the able direction of Sir Daniel Morris has done conspicuously good work has been assured for another term of five years by a grant from the Home Government.—(E. SHEARER.)

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LEAFLET NO. 6 OF THE DEPARTMENT OF AGRICULTURE, BURMA. —"INTRODUCTION OF MOULMEIN PADDY INTO THE AKYAB DISTRICT." —Some Moulmein paddy seed was introduced by the Government of Burma into the Akyab District last year and was sown by various cultivators in that District. This introduction was successful. The grain produced was better than that from local varieties and the cultivation was sufficient —(EDITOR.)

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THE BENGAL SEED, MANURE AND IMPLEMENTS STORE, 28, POLLOCK STREET, CALCUTTA.—As an outcome of many difficulties connected with the supply of good seed to ryots, the Bengal Agricultural Department has opened a Seed Store in the heart of the business centre in Calcutta.

No reliable agency was previously established for the supply to ryots of good seed of the ordinary food grain and garden crops. Mahajans and Banyas usually stock very inferior seed of these crops, because the best seed is either exported or sold locally for consumption each year before seed time. Deterioration of crops

is a natural consequence. It has, in fact, been found that the seed of farm crops obtainable in Bengal from ordinary sources of supply is usually mixed, old, weevilled and poor in germination. Such seed always produces inferior crops.

The seed which is supplied to cultivators from our Store is either grown on the Government Farms or is brought under careful departmental supervision. In this way a beginning has been made towards meeting a long-felt want The seed which is intended for distribution is sent to the Calcutta Seed Store where it is cleaned, tested for germination and stored in rat-proof bins. These bins are also designed to keep the seed in sound condition.

We supply good seed at ordinary rates, Government bearing all the extra expenses including rent of store, cost of etablishment, and other items. More Government seed farms are, however, needed. We also require larger space and better accommodation for storage, as the demands on the Department for good seed are increasing.

Our seed store is intended to demonstrate that a demand for good seed exists. When this demonstration is complete, it is hoped that the good work will be carried on more extensively through private enterprise. The Government Farms will, of course, continue seed improvement and supply improved varieties for experimental and demonstration areas. The millions of tillers of the soil in Bengal, however, require much greater supplies of improved seed than any Government agency can produce.

In other countries (particularly in England and in America) there are seedsmen whose business is to supply farmers with seed which is true to variety and in every way reliable. They strive to improve their seed by cross-breeding and by great care in selection. They use the best grading and cleaning machinery, and they naturally (with advantage to the farmers) compete among themselves to obtain the best possible commercial results.

The Bengal cultivators should be educated to appreciate the value of seed improved in India by the means above referred to

and by other means. The ordinary ryot will not at present pay the higher prices which are necessary to make a "Seedsmen business" pay its way. He may be educated up to this standard in time. The chief demand for seed from the Bengal Seed Store comes at present from big Zamindars.

It may be noticed casually that hardly a century ago English farmers were mostly ignorant of what science could do for them. During a period of some 20 years early in the 19th century great progress was made and has been continued. We possibly may look in time for a similar record of progress in Bengal in seed growing and in other agricultural improvements.

The following statement shows the quantity of each kind of seed distributed from the Bengal Seed Store in 1907 :—

		Mds
C. P. Aus Paddy		91½
Bengal Aus Paddy		3
Aman Paddy	Mds.	
Badshabhog	12½	47
Banktulshi	½	
Samudrabali	11½	
Dadkhani	12	
Khiriajali	1	
Chingirbhushi	1	
Kataribhog	½	
Sukavel	5	
Kanchanchur	1	
Maharajwa	1	
Katangjhali	½	
Kamode	½	
Jaunpur Maize		37
Juar		37
Groundnut		40½
Wheat		66½
Barley		27¼
Oats		25¼
Mustard		32¼
Cotton Seed.		
Buri Kapas		21
Dharwar American		10
Dhaincha		20
Jute		266

POTATOES.

	Mds.
Patna and Naini Tal	261
Madrasi	4
Kalimpong	67½
Irish	27
	1,073¾

SUGARCANE.

Shamsara	2,380 cuttings.
Khari	6,820 „
Ikri	1,20,000 „
Khagir	8,000 ,
Mauritius	5,000
	Mds.
Buck Wheat	3

VEGETABLES.

China cabbage	Some seed of each of the varieties was supplied.
Onion seed	
Beet	
Egg plant	
Turnip	
Soja Bean, etc.	

In all 1,083¾ maunds or 88,354 pounds were distributed including sugar-cane cuttings.

The largest distribution of seed of any one variety of crop was 266 maunds of jute seed which was only sufficient for a very small proportion of the area actually sown. Other seeds distributed had still less effect on total areas. The inference is that a vast field exists for private enterprise in supplying reliable seed to cultivators.

In a series of experiments lasting over several years, the following varieties of crops have proved their superiority over others and are recommended for cultivation :—

Paddy	Aus Central Provinces, fine. Aman Dadkhani, Banktulsi, Badshabhog Samudrabali and Balam.
Jute	Deswal, Hewti, Kakya bombai.
Sugar-cane	Khari for ordinary cultivators. Stands drought and water-logging, is prolific, not damaged much by white-ants, jackals and pigs and gives a good sample of gur.

Ikri	for excessive water-logging.
Maize	Jaunpur.
Juar	Sarun.
Rahar	Sarun.
Wheat	Muzaffernaggar white.
Oats	Dumraon.
Mustard	Raipur and Jubbulpore.
Gram	Patna.
Groundnut	Cuttack.
Potatoes	Patna and Naini Tal.

Good and tested seed of the above-named varieties is stocked in the Bengal Seed Store. Intending purchasers should send in their indents for Jute and Aus Paddy in January; for Maize, Rahar, Aman Paddy and Groundnut in March; for Wheat, Oats, Gram, Mustard and Potatoes in August, and for Sugar-cane in November.

Besides seeds, we store a few manures for the use of cultivators who may obtain small quantities at the lowest market rates. In 1907, we distributed :—

	Mds.
Bonemeal	265½
Superphosphate	165
Sulphate of Ammonia	23
Kainite	9½
Saltpetre	218¼
Castor cake	65½
Safflower cake	5

A few implements of patterns likely to suit India are also stocked in our Depôt.

The net cost to Government of running our Seed Store for 1907 was—rent Rs. 2,400, and establishment Rs. 1,362, or a total of Rs. 3,762.—(F. Smith.)

Ratin.—References to this preparation for the extermination of rats will be found in this Journal, Vol. II, Part 3, and Vol. III, Part 1. It has recently received a thorough trial in Behar at the instance of the Inspector-General of Agriculture. Experiments on caged rats were tried at the Sirseah Research Station and 10 tins were distributed amongst planters in the district for practical trial on both house and field rats.

Two classes of "Ratin" are prepared by the makers known respectively as No. I and No. II. The latter is said to be the more virulent and also to keep the better, but is the more expensive. Both kinds were tried within the period for which the keeping qualities of the preparations were guaranteed, but, in order to make sure of the vitality of the cultures, a tin of each batch was opened and tested bacteriologically at Sirseah. Evidence was obtained that both preparations contained living bacteria

Two healthy house-rats were caught in traps and fed on No. I and No. II "Ratin" respectively. After they had eaten about a tablespoonful each, they were let loose amongst healthy rats in cages. The rat which had eaten No. I did not seem any the worse for it, nor did he infect his cage companions within three weeks. The one which received No. II died within 48 hours, but also produced no infection amongst the other rats within three weeks. Similar experiments with field-rats were tried with No. II only, and again with negative results; no effect seemed to be produced either on the rat which actually ate the "Ratin" or on his cage companions within three weeks.

It is difficult to draw a definite conclusion from the practical trials which were carried out at Sirseah and elsewhere in Behar. "Ratin" No. I was put down in rat-infected godowns at Sirseah and a number of the baits were taken, but no dead rats have been found, and the only evidence we have indicating that some effect may have been produced is that, whereas formerly rats could be trapped in these godowns daily with practical certainty, it is now only rarely that a rat can be caught.

Four out of ten planters to whom the preparation was sent, report similarly that since its application few or no rats have been seen in places which were previously infested, but no dead bodies have been found. The absence of dead rats is not necessarily an indication that the application has been ineffective, since it is, we believe, claimed by the makers that the rats frequently migrate to die.

Four planters report that absolutely no result has ensued from the application, and the remainder failed to carry out the trials.

It would seem, therefore, that "Ratin" does not act as effectually in India (or at any rate in Behar), as it is said to have done elsewhere, but the results obtained in one or two cases are perhaps sufficiently encouraging to justify a repetition of the trials.—(C BERGTHEIL).

* * *

RECLAMATION OF LAKE ABOUKIR.—It is now 21 years ago that the concession of Lake Aboukir, one of the smallest of the great lakes in North Egypt, was obtained from the Egyptian Government. At that time it was an absolute barren tract of about 30,000 acres, dry in summer but covered in winter with sea water a few inches deep.

The work of reclaiming the lake was started by digging the main canal and drains. Large centrifugal pumps were erected in order to pump out the salt water into the sea. This work was found to be very exhausting on the Company's resources, and prospects were at first not bright. Criticism and advice were freely offered by the general public. The Lake was said to be pure sand and the owners were advised to practise colmatage or silt deposition till the lands would drain into the sea or to grow salt-bush and similar plants. Either idea would have taken some 200 years to produce the desired effect.

The outlook, however, from the time the Government allowed a gravitation outlet for drainage into Lake Mareotis, continued to brighten, and owing to the increased demand for Egyptian cotton, prices of land rose steadily. The Company's system of washing and drainage proved a thorough success, and the sale of some of the reclaimed lands soon put it on a firm basis.

Since then, nearly £315,000 have been paid in dividends and debenture interest, *i.e.*, about twice the capital invested. There still remains to the Company about half their land which is now nearly all reclaimed. Most of it is let to native tenants at a yearly rent varying from £5 to £8 per acre.

On Aboukir it is not "two blades of grass where one grew before," but the creation of some 50 square miles of fertile land out of a barren waste now supporting a population of about

12,000. Not only has this wealth gone into the pockets of share-holders, but labourers, tenants, and purchasers have all benefited. Government also now draw a rapidly increasing sum in land tax.—(G. S. HENDERSON.)

* * *

GLUCOSODE PROCESS OF INDIGO MANUFACTURE.—The Glucosode process was worked during the season 1907 at the head factory of the Turcouleah Concern, Chumparan, for the whole of "Moorhun" manufacture. No side by side comparative trials were made (these were made in 1906), but it was decided to compare the total results of a season's manufacture with the working of the ordinary process at the neighbouring factories of the same concern, soil and other conditions being similar.

A total of 62,478 maunds of green plant was worked off by this new process of manufacture. The outturn was 271 maunds of indigo, representing a produce of $17\frac{4}{16}$ seers per 100 maunds of plant. The ordinary manufacturing process was worked during "Khoontee Mahai" to the extent of 9,715 maunds of green plant, the outturn from this being 23 maunds and 25 seers of indigo, representing a produce of $9\frac{12}{16}$ seers per 100 maunds of plant. The ordinary outturn of Turcouleah factory in 1906 was $9\frac{11}{16}$ seers aganist an average of $11\frac{9}{16}$ seers at Muckwah and $10\frac{13}{16}$ seers at Ghyree, these two being the neighbouring factories, with the outturn of which the results of the new process will be compared, the produce there being on the average 15 to 20 per cent. better than at Turcouleah. The average produce at these two factories in 1907 by the ordinary process was for Muckwah $11\frac{10}{16}$ seers of indigo per 100 maunds of plant, and for Ghyree $10\frac{14}{16}$ seers.

If the ordinary process had been worked at Turcouleah, an outturn of $9\frac{12}{16}$ seers of indigo per 100 maunds of plant could, therefore, have been expected, which estimate is confirmed by the fact that this was precisely the outturn during "Khoontee Mahai." The Glucosode process yielded $17\frac{4}{16}$ seers of indigo per 100 maunds of plant, being an *increase of* 76 *per cent.*, or a gain of 117 maunds of indigo of what was manufactured.

The proportion of Java-Natal indigo manufactured was at Turcouleah 26·2%, at Muckwah 32·8%, at Ghyree 23·6%, per cent., the rest being Sumatrana indigo.

The indigo manufactured by the new process was sent to Calcutta in two batches; the first batch was valued by the indigo brokers at Rs. 147-8-0 per maund all round and was shipped to London to be sold there; the second and slightly inferior batch was valued all round at Rs. 145, and was sold in Calcutta for Rs. 146-8-0 per maund.

The cost of the process has been worked out by the Manager at Rs. 25-12-0 per steeping vat of 2,000 cubic feet capacity; 194½ such vats were worked with the process, making the total cost of producing 271 maunds of indigo—Rs. 4,008.

We must, however, add to this some extra manufacturing charges, also the freight and commission on the plus production of 117 maunds of indigo, and the royalty on 271 maunds, altogether about Rs 1,310.

The quality was not so good as was turned out by the same process at Burhurwah factory in the same concern in 1906, by reason of our not having had at Turcouleah sufficient boiler room for the purification of the fecula. The Managing Proprietor of Turcouleah concern estimates that if the ordinary process had been worked, the indigo would have sold at Rs. 10 per maund better all round.

We have, therefore, to deduct from the profit made a sum of Rs. 2,710, representing the deficiency in quality.

The account of profit stands as follows :—

	Rs.	Rs.
Increase by the Glucosode Process 117 maunds of Indigo, at Rs. 145 per maund		=16,965
Deduct, cost of Process as stated by Manager ...	4,008	
Extra charges and royalty	1,310	
Loss in quality	2,710	
Total ...		8,028
Total net profit ...		8,937

	Rs.
Net profit by this new Process per 100 maunds of green plant	=14-5-0
Net profit by this new Process per 1,000 cubic feet steeping vat	=23-0-0

(EUGENE C. SCHROTTKY.)

I have pleasure in publishing in our Journal the above Note by Mr. Schrottky. I will have equal pleasure in publishing any criticisms which may be offered by Indigo Planters or by others who are interested in this enquiry.—(EDITOR.)

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EAR COCKLE—A WHEAT DISEASE.—A Wheat disease, Ear Cockle (*Tylenchus Scandens*), not previously reported in India so far as is known, has been recently discovered in the Punjab, and on at least an area of several acres has destroyed about $\frac{3}{4}$ of the crop.

At harvest, infected crops look quite healthy to anyone passing even closely past them, but brown galls are found in place of the wheat grains and are about $\frac{1}{3}$ to $\frac{1}{6}$ of the size of these. The galls are infested by minute worms.

Investigations up to date have disclosed that there are traces of the disease in many districts in the Punjab, and evidence points to the probability that it may be found over a still wider area, but that it only does excessive damage in specially favourable conditions.

Further investigations are in progress to obtain, if possible, some idea of the area affected and of the damage which is usually done.—(D. MILNE.)

REVIEWS.

Third Annual Report of the British Cotton Growing Association for the Sixteen Months ending 31st December 1907. (Manchester, 1908.)

According to this Report, the total amount of shares subscribed for on 31st December 1907 amounted to £260,632. In order to raise further capital, the British Cotton Ginning Company, Limited, was formed, with a capital of £100,000, all of which has been subscribed. The Association also holds £60,000 worth of shares in the British East Africa Corporation and £30,000 in the Rhodesia Company, making a total capital of £450,000. The annual turnover in cotton alone now amounts to nearly £250,000. A large business is growing up in marketing and insuring cotton, supplying stores, machinery, etc., for planters and others, on which the Association earns a commission. From this it will be seen that the work of the Association has grown considerably.

The Council of the Association have to report that the experiments carried out in India through the medium of Messrs. Shaw, Wallace & Co., of Calcutta, with "Tree" and other cottons have failed. A small quantity of cotton has been produced, and possibly there may be some further return, but in view of the doubtful possibility of this occurring, the whole of the money spent was written off in last year's account. Similar experiments in India have been carried on by Mr. Spence, with Tree cottons. It is understood that these have been rather more successful, but the Association have been unable to take an active part in the same.

The cultivation of Egyptian cotton has been continued in Sind with fairly satisfactory results. The acreage planted and the approximate yield are as follows :—

	Acres.	Yield.
1905	1,000	450 Bales of 400 lbs.
1906	5,000	700 " "
1907	6,000	1,800 " "

An improvement has been made in the system of marketing, and the native growers have received better prices than in the past, but there will be great difficulty in establishing the cultivation of exotic cotton, which requires more care and attention than native varieties. The Association does not think it can do much in this direction, but with the aid of the Government of India it hopes that even if it is impossible to extend the cultivation of Egyptian cotton in Sind, the supply of improved and selected strains of indigenous seed may be able to effect an improvement in Indian cotton, not only in Sind, but throughout the whole of India. The largest tracts of land under cotton at the present moment are in India, and if it were only possible to improve the quality of Indian cotton, Lancashire's dependence on the vagaries of the weather in the United States would become a thing of the past.

In Ceylon the cultivation of long-stapled cotton continues to make progress, and the Association is now arranging for the erection of a small ginning plant in that colony.

In the West Indies important developments appear to have occurred, and the progress recorded in the last report has been surpassed in 1907. Larger quantities of cotton have been grown and have been sold at high prices, and the industry is now established on a permanent basis, so that the West Indies can confidently be looked to for a sufficient supply of the best long-stapled cotton to render England almost independent of the United States.

In West Africa, too, considerable progress has been made, and the report goes so far as to say that the Association is "now convinced that Lancashire can confidently look to West Africa

as the great cotton-producing field of the future." From Lagos alone, 1,050 bales were shipped in one steamer in May 1907. Grants-in-aid are provided by the Government towards which the Association has to subscribe similar amounts. The progress made in this part of the country is interesting, and the following statistics of the value of cotton and seed exported from this colony during the last few years will show this.

	£
1902	200
1903	7,000
1904	12,000
1905	28,000
1906	60,000
1907	100,000

Efforts are likewise being made to establish cotton growing in Sierra Leone, the Gold Coast, North and South Nigeria, Nyassaland, Uganda, Rhodesia, and South Africa, and assistance is being rendered by the Association in Queensland with the same object. So that, on the whole, the Association is to be congratulated on the material progress it has made towards rescuing the Lancashire cotton industry from the thraldom of the United States.—(BERNARD COVENTRY.)

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STUDY OF THE VALUE OF CYANAMIDE OF CALCIUM AS A NITROGENOUS MANURE. BY A. MUNTZ, MEMBRE DE L'INSTITUT, DIRECTEUR DES LABORATOIRES DE L'INSTITUT NATIONALE AGRONOMIQUE, AND BY P. NOTTIN, INGENIEUR-AGRONOME. (*Annales de L'Institut Nationale Agronomique.* 2e Serie. Tome VI. Paris, 1907.)

ANY fresh information which can be given regarding the problem of the future supplies of nitrogen for agricultural purposes must be of importance to any one interested in safeguarding and improving the agriculture of any country, and the recent experiments of Müntz and Nottin in France on cyanamide of calcium appear to call for some notice. In the article quoted above the authors give a complete account of its history, describe

its nature, and record a series of both laboratory and field tests, which are well worth the perusal of the student of agriculture.

As pointed out by them, agriculture and the industries consume nitrogen in quantities that are steadily increasing, while the known supplies of combined nitrogen existing in animals, vegetables or fossils, are very restricted. This has led to attempts to utilize the resources of atmospheric nitrogen by combining it with other substances. The fixation of free nitrogen is brought about in nature by the action of bacteria in the soil and at the roots of leguminous crops, but the process of formation is slow, and the nitrogen formed is mixed with a large volume of earth and does not lend itself to easy extraction. The fixation of nitrogen by chemical means gave but poor results until more recent investigations opened out prospects in two directions. One based on the researches of Cavendish and worked out in practice by Birkeland and Eyde, has resulted in the formation of calcium nitrate by the use of atmospheric nitrogen and was for the first time carried out in Norway. The other was based principally on the combination of free nitrogen, with metals and the carbides of metals. Margueritte and de Sourdeval had obtained cyanide of barium by passing nitrogen over a mixture of carbon and baryta at a high temperature. From this it was discovered that nitrogen is taken up by the carbides of the metals and by metals such as magnesium and calcium, and Maquenne, in 1892, combined nitrogen with the alkaline earths at a red heat. These reactions, however, were only useful from the point of view of laboratory work. They were different from the means of fixing nitrogen discovered by Frank of Charlottenburg and by Caro. These experts endeavoured to apply the discoveries of Margueritte and de Sourdeval to the manufacture of cyanide. They tried the action of atmospheric nitrogen deprived of its oxygen, on carbide of calcium, a commercial product, but the reaction was different from that which they expected, and cyanamide of calcium and carbon were formed.

$$CaC_2 + 2N = CN_2Ca + C.$$

Cyanamide of calcium was not a new product, for it had already been formed in the laboratory. The Society "Cyanid Gesellschaft" had made cyanamide of calcium in an experimental factory at Berlin. The results of these investigations were satisfactory, and in 1906 one factory was started at Piani d'Orte in Italy, and two were under construction at Sebenico in Dalmatia and Notre-Dame de Briançon at Isère.

It is thus that nitrogen drawn from the air and fixed by the carbide of calcium as cyanamide has come into use for agricultural purposes, and it is from this point of view that the product has been studied in this article.

The following is a description of its manufacture. Carbide of calcium in a fine state of subdivision is placed in retorts resembling those used for gas-making and brought to a white heat. A current of nitrogen is passed over the carbide of calcium which is then almost entirely converted into cyanamide. The nitrogen is obtained by first passing air over copper filings brought to a red heat, by which the oxygen is abstracted, and the oxide of copper is again reduced by passing over it tar spirit, and thus making the copper indefinitely available.

Crude cyanamide of calcium is very impure, some of the carbide having remained unchanged. This is got rid of by crushing it up and allowing it to remain exposed in a humid atmosphere, when it is converted into acetylene and lime. The commercial product contains only 20 to 22 per cent. of nitrogen, while the pure product, CN_2Ca, contains 35 per cent. The authors then proceed to describe some of its properties, and experiments made in the laboratory. They find that cyanamide of calcium is easily changed into ammonia and that, as shown by S. F. Ashby,* under the action of soil microbes, this is effected with a certain degree of rapidity. The researches of Gerlach and Wagner† on Sugar Beets which commenced in 1901, show that nitrate of soda, sulphate of ammonia and

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* *Journal of Agricultural Science*, 1905, I, 358.

† *Landw. Presse*, 11th July 1903.

cyanamide give the same results, and Strohmer,* Schulze,† and Hall‡ admit that the new manure is equal to nitrate of soda and sulphate of ammonia. Afterwards Grandeau§ and the "Societa Italiana per la fabricazione di prodetti azotati per l' agricultura" in 1906, came to the same conclusions. But there would appear to be an exception to this, as shown by Perotti‖ and other workers, that where cyanamide is applied in excess, as for example corresponding to 750 kilos of sulphate of ammonia per hectare, the germination of seed was checked and in some cases plants were killed. To overcome this difficulty, it is suggested by some that the manure should be applied some time before sowing, from which it may be inferred that the cyanamide is not used by plants till after its conversion in the soil.

In order to determine the order in which the plants absorb nitrogenous manures, Röszler¶ made series of pot-cultures, in which he determined the quantity of nitrogen absorbed by the various manures every ten days. He found that during the first 28 days, the absorption of nitrogen from cyanamide was *nil*, while that of nitrate of soda was 40·3 per cent. and sulphate of ammonia 48·40 per cent. This to a certain extent explains the contradictory results obtained by the application of cyanamide in large quantities.

The authors then explain their own experiments to determine the agricultural value of cyanamide and especially their study of its transformation into nitrate, under which form it is almost exclusively taken up by plants. They find that if cyanamide is used in moderate doses, then nitrification is as complete and rapid as with sulphate of ammonia, and that quantities, such as would correspond to a full dose of manure, can with every

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* *Osterr, Ungar, Zeitsch, f. Zuckerind, und Landw.*, 1905.

† *Jahresber, d. Versuchsst. Breslau*, 1904-5-8.

‡ *The Journal of Agricultural Science*, I, Jany., 1905.

§ *Journal d' Agriculture Pratique*, 1906, I, p. 8.

‖ *Staz sperim Agrar.* Ital. 1904, 38, 581.

¶ *Ill. Landw. Zeit.* 1905, 25, 311.

advantage be applied, provided this is done in a small dose at a time, otherwise large applications at a time tend to paralyse the action of the nitrifying organisms of the soil. It must, therefore, be used with prudence. They then enquired into the action of the caustic lime which accompanies the cyanamide, and their experiments proved that any retarding effect was due to the action of the cyanamide itself rather than to the lime, and that soils rich in organic matter can advantageously take up more of the manure than soil deficient in this constituent. They conclude that it has a toxic effect on the organisms of the soil when used in excessive quantity, but that this is reduced to a negligible quantity if it is used in moderate doses.

The question of possible loss of nitrogen in the storage of cyanamide was investigated. They found that, kept in sacks and stored in a dry place, there occurred hardly any loss, and that such losses as have been supposed to have taken place by some, have been greatly exaggerated. They also considered the effect of mixing other manures with cyanamide and found that when mixed with kainit there was no loss of nitrogen at all even after 42 days. With superphosphate it was otherwise, and a loss of 5 per cent. was discovered. It would, therefore, seem necessary to avoid making a mixture with this manure. They further recommended that before application, cyanamide should be mixed with an equal quantity of damp earth or be slightly watered, so as to reduce it to the consistency of superphosphate, and they say that, if applied in this way, there will be no loss of nitrogen, any ammonia given off being retained by the water. Their laboratory experiments then indicated that cyanamide was a nitrogenous manure analogous to sulphate of ammonia, but it became necessary to verify this by a series of field experiments, and in order to show also that it had no pernicious effect on plants. With this object they planned comparative experiments in various parts of the country with crops such as wheat, oats, mangels, sugar beets, potatoes, maize, pasture, fodder crops and vines. For details of this work I must refer the reader to the original article, but the following mean results obtained with wheat and

oats and reduced to weight per hectare afford fair examples of the deductions obtainable from the use of the manure.

Wheat.

	Cyanamide applied before sowing.	Cyanamide applied with the seed.	Sulphate of Ammonia.	Test Plot.
	Quintals.	Quintals.	Quintals.	Quintals.
Total weight	92	97	88	83
Grain	30	33	28	27
Straw	57	56	51	48

Oats.

	Cyanamide applied before sowing.	Cyanamide applied with the seed.	Sulphate of Ammonia.	Test Plot.
	Quintals.	Quintals.	Quintals.	Quintals.
Total weight	93	93	95	84
Grain...	33	32	33	30
Straw...	56	55	56	47

The conclusions to be drawn amount to this, that cyanamide applied before or at sowing time, gives the same results as sulphate of ammonia. And, further, the field experiments demonstrate that cyanamide does not affect germination, if the quantities usually applied for agricultural purposes are used. It has given good results with an application of 200 kilos per hectare, the quantity which may be considered normal.

It would thus appear that cyanamide may be considered equivalent to sulphate of ammonia and that it may be substituted for this manure and applied in the same manner.—(BERNARD COVENTRY.)

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FARM LIVE STOCK OF GREAT BRITAIN. BY ROBERT WALLACE. Fourth Edition, pp. 758 and 214 Plates. Published by Oliver and Boyd, Edinburgh. Price 14*s*.

PROFESSOR WALLACE's book on the Farm Live Stock of Great Britain has long been recognised as the standard work on the

subject. The present edition which has been entirely re-written and more than doubled in size, brings the account of the previous editions thoroughly up to date. The history and present position of the British breeds of Farm Live Stock are exhaustively dealt with, and the general management of live stock in health and disease is treated in a manner which will commend the book to all practical men. For the numerous photographic illustrations which in this, as in the previous editions, are a great feature of the book, we have nothing but praise. Great care has been taken in placing the animals so as best to show the characteristic points, and the beautiful half-tone reproductions reflect great credit on the publishers. We congratulate the author on the great advance achieved in this edition which, we are confident, will enjoy a wide circulation among all those interested in the art of breeding.

Great Britain has led the world in the improvement of all classes of live stock, and hence a study of the history of breeding and of the results achieved there is instructive. What strikes one most forcibly at the start is the extraordinary number of breeds of cattle, sheep and horses found in such a comparatively limited area, notwithstanding that in the general improvement of stock during the last century several breeds have entirely disappeared. To take cattle alone, Professor Wallace describes at least sixteen distinct breeds, each occupying a position in the agricultural economy which apparently at present cannot, with the same advantage, be occupied by any other. Thus, for a time the old long horn breed was threatened with being crossed out of existence by the more popular short horn, but it was realised, before it was too late, that the long horn was peculiarly suited to certain agricultural and climatic conditions, and now it is to some extent re-establishing its former position. The truth is that the various breeds have been largely shaped by, and become adapted to, the environment in which they have been produced, and hence, unless the conditions which have given rise to a particular breed have materially changed, the greatest caution must be exercised in attempting to replace it by another

whether by complete substitution or by crossing. This is a fact which has not always in the past been appreciated in India and which goes far to explain the numerous failures that have attended attempted short cuts to cattle improvement by ill-advised crossing.

The last century has witnessed a remarkable improvement in British breeds of cattle—an improvement effected for the most part by judicious mating and systematic and rigorous selection within each breed. The power which lies in the hands of the breeder to mould a breed to a particular type, whether as regards form or as regards certain qualities, is little short of marvellous. It is a noteworthy fact that, in the case of the breeds which have come most to the front, a very few men have been, at any rate in the initial stages, mainly responsible for the improvement. These have been men of rare judgment and foresight who, having in their mind's eye a particular type as the goal to be aimed at, have kept that steadily in view, until after years of patient effort they have achieved the desired result.

The advantages which have accrued to British agriculture from the improvement effected in its cattle are incalculable. Producers and owners of the best strains have benefited from the very high prices commanded by their stock. With the dissemination of the latter and the influence which they have had in raising the standard of stock all over the country, the farming community at large has greatly benefited, in that they have had put into their hands a better and more economical class of stock—stock that for the same feeding and attention yield a much higher return than formerly. The demand from all parts of the world for well-bred stock has been and is enormous. In recent years, indeed, and largely as a result of this foreign demand, no branch of farming has paid so well as the rearing of good pedigree stock.

In India the better breeds of cattle are proof of what can be achieved by careful breeding. Superior specimens of the Gujerati work bullock, for example, would be hard to beat in any country for the combined qualities of shapeliness, strength, speed

docility and endurance. Or, again, to take milk breeds, Montgomery and Sindi cows compare not so very unfavourably with European standards. On the other hand, there are very large tracts, usually where the cultivation is of an intensive character, in which cattle-breeding has received the scantiest of attention. As a rule, India's better breeds have been produced in arid, slightly cultivated tracts by nomad tribes, whose herds of cattle have constituted their main property and means of subsistence, and who have made it a special care to, as far as possible, breed from superior specimens. In recent years various causes have contributed to diminish the supply of good cattle available from the professional breeders. In some cases famine has wrought terrible havoc in their herds, in other cases the extension of cultivation made possible by canal irrigation has contracted the grazing areas and has converted the professional breeder into an agriculturist, whose main interest it is to raise good crops rather than to rear good cattle. The problem in India, therefore, is not only to improve the many inferior breeds but to maintain and, if possible, raise the standard already attained in the case of those superior breeds. It is a very much more difficult one in India, a country of small cultivators and small resources, than in England. Here we cannot expect to find private individuals with the necessary breadth of outlook and the necessary capital and patience to leave their impress on any breed. The peculiar conditions of India and the magnitude of the interests involved, make Government assistance desirable or imperative, at any rate, in many cases, and this fact has already been recognised in several provinces. Where Government assistance is provided, the first duty of those entrusted with the task of cattle improvement in any tract is a very careful study of the agricultural and economic conditions with a view to determining the type which is required and which, taking all the circumstances into view, will be suitable for that tract. This may appear to be a truism, but in the past there have not been wanting mistakes which show the great necessity of laying down a sound policy in the beginning—a policy

which, once adopted, can be adhered to. It must never be forgotten that a breed may be good in itself and yet wholly unsuited to the tract in which it is intended to be introduced. The required type having been determined, the practical measures taken to establish it will consist in breeding bulls of that type for distribution and in encouraging that class of animal by prizes at cattle shows and in every other way possible.

The provision of adequate grazing and fodder supplies is the crux of the whole question of cattle improvement. Without this provision there can be no sound basis on which to work. As in the past, we shall have to look for our very best cattle to those regions where there are extensive areas of waste land. There are large tracts which can never be capable of cultivation, and in the interests of agriculture these should be thrown open to grazing as far as is necessary. Such tracts may not show such a large direct revenue, as they would under protected forest, but the indirect benefits to the agricultural community would more than compensate. On the other hand, we cannot hope to reserve indefinitely, as grazing areas, lands which will give a substantially higher return under the plough. Past experience has repeatedly demonstrated the necessity of providing reserves of fodder if our better breeds are not to be decimated in times of prolonged drought. How exactly this is to be done is very difficult to say. It obviously involves large questions of organization, and the means employed will probably vary in different localities.

In the more highly cultivated tracts where the agricultural population is large and the holdings small, the problem of an adequate food-supply is still more difficult. The village wastes are, as a rule, incapable of supporting any large number of cattle, and too often they have been encroached on by cultivation to an extent which should never have been allowed, for, apart from the grazing which they afford, they are of value in providing that free run outside which is essential if cattle, and especially young stock, are to thrive properly. In such tracts the major portion of the food must be supplied from whatever is available

from the cultivated fields. At present the quantity so provided too often constitutes little beyond a starvation ration, yet presumably the cultivator gives his cattle as much as he can afford. If that be so, he can only afford to increase his fodder crops or to purchase additional feeding stuffs, provided he has put into his hands a more efficient animal—an animal which will give him a bigger return for a given quantity of food. What the small cultivator requires is a good general purpose cow—a cow that will give a fair yield of milk, which will help so far to cover the cost of her keep, and that at the same time will produce good stock for work purposes.

The most encouraging feature with regard to cattle improvement in India is the steadily increasing demand for really good cattle—both work bullocks and milch cows. Within the last few years prices for the best classes of stock have risen fifty per cent. or more, and with average agricultural prosperity there is every probability of these higher prices being maintained or still further enhanced. Already, too, a demand from abroad has set in, and this is capable of indefinite expansion, provided good stock can be produced in sufficient quantity. The prospects for breeders have never been brighter, and we trust that this fact, combined with the assistance which is being given by Government in various provinces, will give such a stimulus to cattle improvement all over India as will bear fruit in the near future.—(E. SHEARER.)

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STUDIES IN THE EXPERIMENTAL BREEDING OF THE INDIAN COTTONS. AN INTRODUCTORY NOTE. BY H. MARTIN LEAKE, M.A.

THIS interesting Note on the Breeding of Indian Cottons by the Economic Botanist to the United Provinces appears in the Journal and Proceedings of the Asiatic Society, Vol. IV, No. 1, 1908. It shows very careful and precise observations on the part of the author and is a good example of the accurate research work which is so much needed in this country. The experiments have

reference to six species of Indian cottons given by Gammie in his "Indian Cottons."* They are :—

Gossypium arboreum, Linn.	*Gossypium indicum*, Lamk.
,, *herbaceum*, Linn.	,, *neglectum*, Tod.
,, *intermedium*, Tod.	,, *cernuum*, Tod.

The above species, the author informs us, form a definite group, the members of which, when crossed *inter se*, are completely fertile. They afford a range of variation which, added to the readiness with which the flowers may be handled and the duration of the flowering period, gives most suitable material for a study in plant-breeding. By far the most interesting portion of the author's work is that in which he has apparently established an accurate factor for the determination of "species" and "varieties" based on the measurement of certain portions of the leaf The determination of this factor was the result of numerous measurements, numbering over 10,000, and the plants for which this factor has been determined, number considerably over one thousand, and the limiting values have been found to be 0·8 and 5·1. Plants for which this factor bears a value between 0·8 and 2·1 are classified as bearing palmatifid—or 'broad'-lobed—leaves, while plants for which this factor bears a value of 3·0 or over are classified as being palmatisect—or 'narrow'-lobed—leaves. If, now, a plant of which the leaf-factor is less than 2·1 be crossed with a plant of which the leaf-bearing factor is greater than 3·0, it is found that the leaf-factor of the offspring in the first generation approximates remarkably to the arithmetic mean of the two parental leaf-factors, and he has proved by a large number of experiments that this leaf-factor with one exception proved to be a constant character for a particular plant.

The author further appears to establish the fact from careful observation that cross-fertilization of cottons under natural conditions is of common occurrence and states that this phenom-

* The Indian Cottons. By G. A. Gammie, F.L.S., Professor of Botany, College of Science, Poona. Printed at the Government Central Press, Calcutta, 1905.

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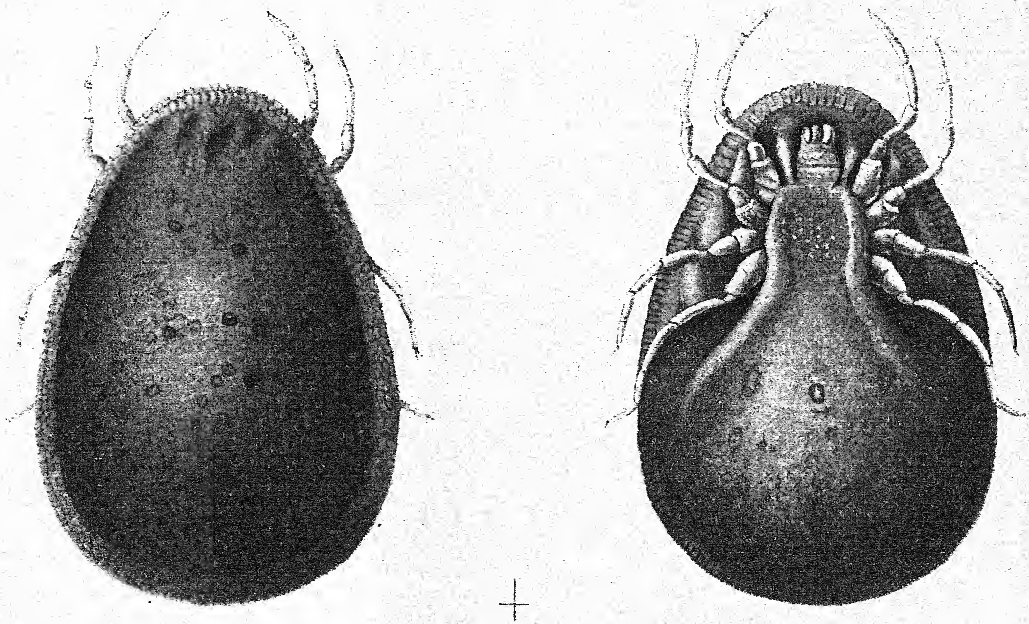
menon requires to be emphasized in view of the fact that it has recently been denied. It is impossible at present to state with certainty to what extent cross-fertilization takes place, but the evidence so far obtained indicates that natural crossing occurs with sufficient frequency to render it impossible to keep types pure when they are grown in the proximity of other types.

For further details of these investigations the reader is referred to the author's Note.—(BERNARD COVENTRY.)

PLATE XL.



A. J. I.

ARGAS PERSICUS.

Much enlarged.

Huth, Lith? London.

SPIROCHÆTOSIS IN FOWLS DUE TO THE FOWL TICK (*ARGAS PERSICUS*).

By Colonel H. T. PEASE, C.I.E., I.C.V.D.,

Inspector-General, Civil Veterinary Department.

Many poultry owners in various parts of India must have been greatly annoyed from time to time by the serious loss of valuable fowls which have been swept off in the course of a few days by an epidemic which has, probably, generally been thought to be a form of fowl cholera.

I have often seen the whole of the poultry on a run thus carried off, and before it became the custom to make careful blood examinations of all animals suffering from obscure diseases, have been led by the clinical symptoms to diagnose the disease as cholera. In the year 1900, however, Conductor Dare of the Supply and Transport Department at Mian Mir, to whom I had lent a microscope for the purpose of diagnosing surra in camels, had the curiosity to examine the blood of some ducks which were dying off rapidly from an obscure malady. To his great surprise he found the blood swarming with a peculiar organism, and on his bringing some in to me, I was able to ascertain that they were spirochætes. Since that time, the disease has frequently been met with in the Punjab and short notes on the subject have been published in the *British Medical Journal* and *Indian Medical Gazette* as to its occurrence in Central India, by F. Reaney, I.M.S.

A short note on the occurrence of the disease in the Punjab was published in the January number of this year's *Journal of Tropical Veterinary Science* by Mr. Montgomery.

As the disease is an important one from the point of view of the poultry keeper, I propose in the following short note to

give a *résumé* of what is already known of the subject, in the hope that by presenting it in a handy form, it may prove of use to poultry owners For this purpose, I shall quote very freely from papers which have already been published in other countries, and especially Marchoux and Salembini's note in the *Annales de l'Institut Pasteur*, t. xvii, No. 9, pp. 568-580, in regard to the disease itself, as well as from the excellent article by Lounsbury on the Fowl tick, which was published in the *Agricultural Journal of the Cape of Good Hope* in September 1903.

How the disease commences.—The disease generally follows the introduction of new birds into an infected area. It appears to be probable that birds kept in an infected area acquire immunity owing to their having been attacked and recovering. It has been noticed, however, that when new clean birds are introduced on to the run, they may become infected at once and commence to die, and that in such cases, some of the birds, which previously were apparently immune, became attacked and died. Either the immunity was therefore not very strong or lasting or the "spirochæte" increased in virulency by being passed through the new fowls. Montgomery thinks that age carries with it a certain amount of immunity even when the fowls come from non-tick-infected districts. It certainly does in tick-infected areas.

The way in which an outbreak of the disease usually occurs is that birds are brought into a run which may have had no chickens on it for some time, or where chickens already exist. In a few days they are covered with larval ticks resembling lice, and are noticed to be sick.

Cause of the disease.—The cause of the disease is the presence in the blood of a peculiar fine spiral thread-like body, microscopical in size, a good idea of a highly magnified specimen of which may be obtained from the illustrations here given.

Symptoms produced.—It generally appears in an epizootic form, a number of fowls being attacked. The first intimation of the occurrence of the disease is very often the sudden death of a few fowls. More commonly, however, the first symptoms

shown are diarrhœa, loss of appetite, somnolence, the feathers erected and the comb pale. The fowl no longer perches, and as the disease progresses it lies down, the head, which it cannot raise or place under the wing, resting on the ground. Death generally occurs suddenly in convulsions.

At other times, the disease takes on a more chronic form and the fowl, after apparent recovery, becomes again dull and remains crouching on the ground, the feet being paralysed.

Some days later, paralysis reaches the wings, the fowl becomes very thin and dies cachectic in 8 to 15 days.

At other times, recovery may take place after the first attack and more rarely also after an attack of paralysis has taken place.

If the temperature be taken, it will be seen to follow a characteristic curve. It is as much as 107° to 109° F., and remains in the neighbourhood of this during the four or five days of the first stage, when it falls, soon returning to normal. When the fowl is dying, it generally falls below normal.

If the bird be examined after death in the first stage, the spleen will be found to be about three times the normal size and the liver also will be greatly enlarged. The other organs are not much changed. The heart blood remains fluid and dark red in colour.

If the blood be examined microscopically during the first period of the disease, *i.e.*, whilst the temperature is raised during the first four or five days, the "spirochæte," the organism above-mentioned, will be found in it.

The following description of what occurs in a healthy susceptible fowl, when a little blood containing the organism taken from a diseased fowl is injected under the skin, is useful as showing the course which the disease runs.

Some few hours after the injection is made, the temperature rises to 107° or 108° F. The next day diarrhœa appears, and the chicken is dull and does not feed, the temperature being 109° F., or even more. After 24 hours, a microscopical examination

will reveal the presence of a few "spirochætes" in the blood.

The temperature remains in the neighbourhood of 109° F., for three or four days, then it falls below 105° F., and sometimes to 104° F.

The "spirochætes" have been constantly increasing in numbers, which may be very considerable. The temperature falls when the quantity of parasites has reached its maximum in the blood.

These "spirochætes" are at first few and isolated, and later unite, forming loose masses which later on become compact, forming large groups. When these masses form, the crisis occurs. In the acute or severe form they precede death by a very short time.

Signs of recovery.—If the fowl be going to recover, the general condition improves, the loss of weight stops, the temperature rises to normal, and perfect health soon returns. It takes about a fortnight, however, for the fowl to regain its original weight. If the animal has been partially paralysed, recovery takes much longer.

Signs of the chronic form.—When the disease assumes the chronic type, the weight continues to fall, the temperature remains below normal, paralysis supervenes and death soon occurs in probably 12 to 15 days.

Immunity.—A fowl once recovered from the disease possesses absolute immunity, and this is early established. It appears possible to confer immunity, by means of the serum from infected fowls. Fowls kept on an infected run apparently become immune if they survive, but at the same time, apparently immune birds will succumb when infection has again been started by new birds; possibly the disease may become intensified by the passage of the spirochæte through susceptible birds.

Susceptible animals.—When the disease occurs on a run, the other fowls generally take it, but some may escape. Young chickens are susceptible to both the natural and inoculated

disease. Their general condition, however, appears better during the course of the disease, and they may run about and feed till death.

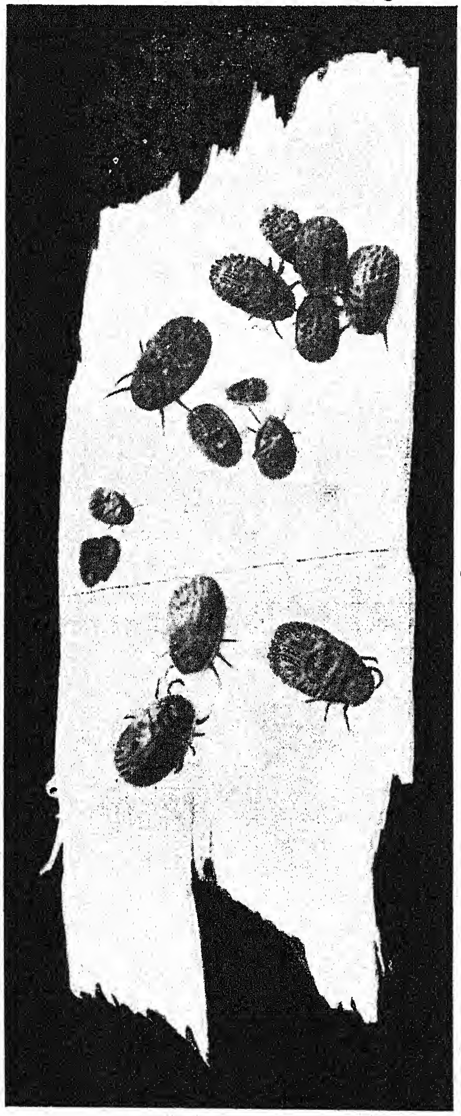


FIG. 4.—The fowl tick (*Argas persicus*) under a piece of bark (after Lounsbury).

The goose is very sensitive as is also the duck and guinea-fowl. The pigeon shows some dullness after inoculation, but no organisms in the blood. The dove and sparrow also take it.

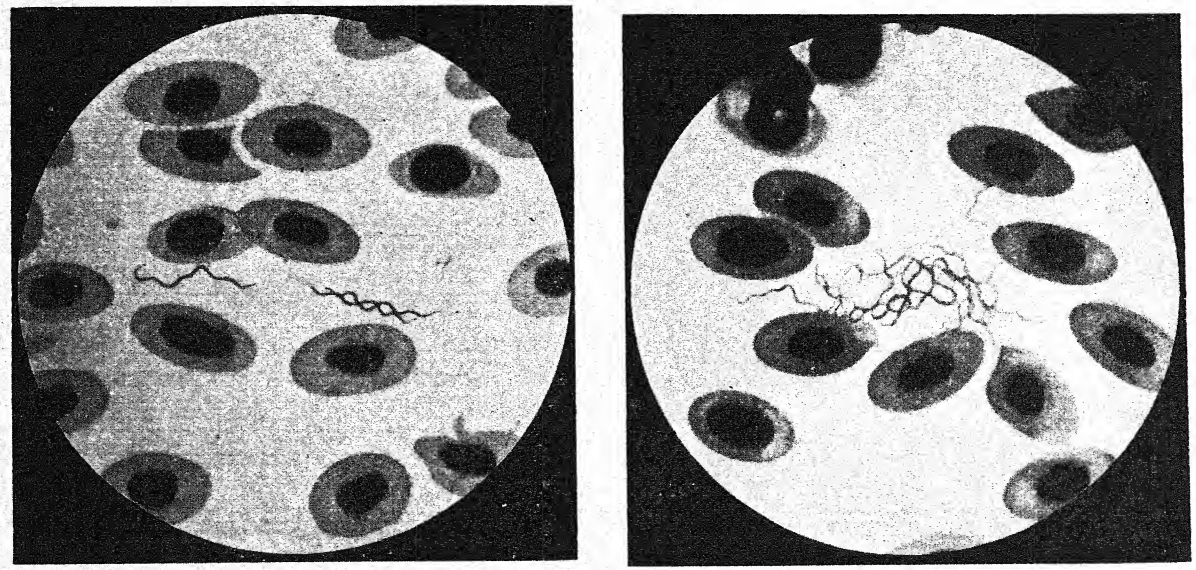


FIG. 5.—*Spirochæta marchouxi gallinarum* in the fowl's blood (after Montgomery) showing clumping × 1000.

Well-bred English fowls are, as a rule, very susceptible, and I have seen the whole of them taken off a run where the country fowls remained apparently healthy.

How the disease spreads.—The question of how the natural infection of fowls takes place and how the disease spreads so rapidly in a fowl run, naturally interested Marchoux and Salembini, and it suggested itself to them that probably a fowl parasite acted as an intermediate host to the spirillum. They therefore proceeded to ascertain by experiment whether this is the case. On examining the infected runs, they found, hidden under the wood or in the interstices of planks, a great number of a peculiar form of ticks. These have somewhat the appearance of a woodlouse. They belong to the family *Argasidæ.* These ticks, the Indian variety of which is named *Argas persicus*, (Plate XL) are pretty widely distributed in India and are the common fowl ticks of the country. The accompanying illustrations will give a very good idea of their appearance.

Marchoux and Salembini ascertained experimentally by allowing the ticks to bite first diseased, and later on healthy, fowls, that the latter were infected in this way. The following experiment may be quoted:—

In a glass vessel covered by metallic wire a fowl No. 1 and a few ticks, which had been allowed to feed on an infected fowl, were placed.

In a wooden case, one wall of which was made of brass wire, they placed a healthy fowl No. 2 and an infected fowl.

Result.—Healthy fowl No. 1 became infected in nine days, and No. 2 in four days.

Similar experiments were repeated several times with the same results, so that it has been satisfactorily demonstrated that ticks are capable of transmitting the disease, and that they do so in natural infection.

It has also been proved that ticks, which have fed on a fowl infected with spirochætosis, have been proved to be capable of transmitting the disease to healthy fowls five months after biting the sick one. It is quite possible that the ticks preserve the spirilla

for a still longer period, and hence it is that they are such important agents in the cause of outbreaks of the disease. It is a curious fact that it is necessary to keep the ticks at a suitable temperature (about 30 to 35°F.), after they have been fed on blood containing the spirochætes. In ticks kept at from 58 to 68°F. after feeding, the spirochætes seem to disappear after three or four days If kept at a low temperature they may bite fowls repeatedly without infecting the birds, although the ticks harbour the parasites. Borrel and Marchoux found that ticks could be maintained three months at a low temperature without being infective, but on placing them at 95°F., the spirochætes reappeared in the ticks, and the latter again became infective. These facts are interesting as showing the influence of climate and season on the prevalence of the disease. Once they have bitten infected birds they are capable of carrying the infective parasite in their bodies for a very long time, and when the conditions become favourable, of infecting clean birds brought on to the run months afterwards, and giving rise to a fresh epidemic. The spirochæte are parasitic in the tick as well as in the fowl, the parasites passing to the offspring of infected adult ticks It has long been known that the fowl tick does cause heavy losses in poultry, but the exact method by which this occurred, was not generally known. We are now aware of the cause of the losses and the means by which they are brought about.

The fowl tick: Argas persicus.—The bodies of these ticks are usually oval, flat and thin, much like that of a bed bug. They attack poultry by night and are found in crevices of the walls, boards, etc., in fowl houses, by day. Both male and female are much alike, excepting that the females after feeding increase in size. The only sure way of distinguishing the male from the female is by noting the shape of the genital orifice, which is situated just behind the mouth parts, which are situated beneath, on the under side of the front of the body, and are not visible from above; that of the male is relatively inconspicuous and is surrounded by an oval ring; that of the female appears as a transverse slit. The ticks measure, when adult, a quarter of an

inch long and about a sixth of an inch broad. Females which have fed may measure from two-fifths to half an inch long and proportionately wide.

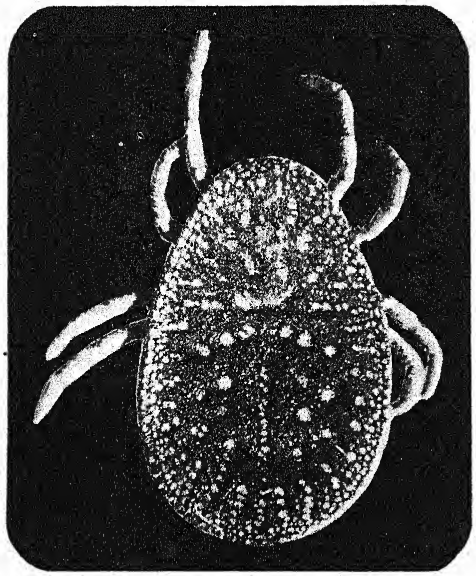


FIG. 6.—The fowl tick (*Argas persicus*, after Lounsbury).

The surface of the skin is thrown into folds when the animal is not fed, but becomes smooth after a meal. The color before a feed is chocolate brown, except at the margin, which is always pale brown. Just after a feed the general surface is a ruddy blue-black, and a few days later the ruddiness disappears. The legs are almost colorless.

On the upper surface of the body a large number of depressed discs are noticed, the numbers and arrangement of which vary with individual specimens. There are three constantly large ones arranged in the form of a triangle on each side of the middle of the body, a little less than half way from the rear margin, about ten other relatively large ones in front of these, a row of small ones from between the two triangles to the rear margin, and shorter rows up each side directed from the margin towards the middle. Discs of similar appearance occur on the under-surface.

The mouth parts lie in front of and between the front legs. The rostrum is a short club, studded with four rows of recurved spines. It is through this organ the blood is drawn. The mandibles which are used to cut a hole through the skin for the entrance of the rostrum lie side by side above it. They can be extended and are furnished at the tip with a cluster of hard, hook-like processes which are capable of independent movement. The tick uses them for clinging to the flesh. The ticks have no eyes and prefer darkness, avoiding the light.

Life history of the tick.—Lounsbury has carefully traced the life history of the *Argas persicus.* Unlike the female of the Ixodid tick which dies after laying her eggs, the female of *Argas persicus* lives on and may feed and lay other batches of eggs afterwards : egg-laying in warm weather generally begins about a week after feeding. The eggs are laid in the crevices in which the ticks hide during the daytime in the walls, cracks between boards or under the bark of a post. The eggs are round and brown, the number laid each time varying from about 20 to 100. They begin to hatch out in about three weeks.

The larva.—When newly hatched, it is an almost colorless six-legged creature, with very long legs. It is about a thirtieth of an inch in length. It feeds as soon as it gets on to the fowl, and generally drops off on the fifth day, but some may remain on up to the ninth or tenth day. When fully engorged, it is a deep purplish black, and measures about a tenth of an inch in diameter. Just before leaving the fowl, it elongates and flattens, assuming the shape and form of a miniature of the adult, which better fits it for crawling and concealing itself. It now avoids the light, generally getting into some crack where it rests until moulting occurs, and it arrives at the second stage, when it has four pairs of legs and the breathing orifices appear. It again feeds at night, the meal being quickly taken, and seeks concealment, where in about a fortnight a second moult takes place and the third stage is reached. It again feeds for the third time and then measures about a quarter of an inch long. It again hides for a

few weeks, and a third moult takes place, when the tick has reached its adult stage.

In the adult stage the ticks feed, at night about once a month in the hot weather when they can, the female increasing in size whilst the male remains about the same size. After each feed the female lays eggs. When the weather is cold, the periods between the feeds increase. In ticks kept by Lounsbury in confinement it was noticed that few eggs were laid after the fourth feeding of the adult, and fewer after the fifth and sixth. Some of his adults fed seven times.

Longevity.—The fowl tick at all stages is able to exist many weeks without food or drink in hot weather, but in the early stages has not so much vitality as in the later adult stage. No larvæ survived more than two months, and no nymphs beyond four months, but adults were still vigorous after a year. Lounsbury says that it is quite probable that all stages of the tick will survive without food for much longer periods than those mentioned under natural conditions in disused fowl houses. He has found larvæ abundant in a fowl house five months after the last fowls had been removed; and he found numerous nymphs and adults in an outbuilding to which no fowl has had access for fifteen months.

Getting rid of the tick.—This is by no means an easy matter, as Lounsbury says. From a consideration of the habits of the fowl tick it will be apparent that it may be combated in several ways; (1) by seeking them on the walls and roosts at night when they come out to feed; (2) by destroying them in their hiding places with a contact insecticide; (3) by destroying the larvæ before they leave the fowls; (4) by so supporting the roosts that the ticks cannot reach the fowls. The first measure is impracticable. The second would do if it could be thoroughly carried out, but this is generally not possible in Indian fowl houses owing to their construction and to the difficulty in killing the ticks by means of any insecticide. The third is also not easy, although often recommended in Australian journals. It is perhaps better to try a combination of methods. Lounsbury

quoting a plan adopted in Grahamstown, which proved successful, says :—

"The plan adopted by me to get rid of the fowl tick was to burn all the old roosts and nests. Then I had the wooden walls of the fowl house well brushed over with hot coal tar. I then procured four new roosts of clean deal with the edges planed off and slung them with wire from the roof, hammock fashion, two lengthwise and two across at each end. Thus no roost touches the sides or walls of the house. The object of supporting the roosts by wires in this way is to preserve the fowls from being pestered at night by the ticks which harbour in the crevices of the walls. In the day time the fowls can protect themselves if they have a good run. On no account should poles with bark on be used for roosts, as the ticks will hide under any loose pieces. If any ticks make their appearance in the nests, I make free use of paraffin applied with a brush, and this is effective in destroying them. The floor is regularly swept clean and sprinkled with wood-ashes or lime. Since adopting these measures, about two years ago, I have not lost a fowl by the pest. I may add that some of my neighbours have cleared their fowl houses by the frequent use of strong solution of some sheep dip applied with a spray pump or a garden pump."

I should recommend scraping and releeping the walls and covering all the inside with a thick coating of hot coal tar, carefully filling up all cracks in woodwork, etc., and slinging perches as above recommended, cleanliness of the floor and keeping it sprinkled with wood ashes. If not too numerous, fowls covered with larvæ may be freed from them.

To destroy larval ticks on poultry they may be brushed over with paraffin, which destroys them, but also rather scalds the skin of the fowl. Sweet oil brushed over the fowl acts satisfactorily. Lately, Bevan states that in Africa the practice of dipping poultry in warm solutions of some of the common sheep dips has found favour, and very excellent results have followed the use of a warm solution of Cooper's dip of rather weaker strength than the mixture used for sheep. The immediate effect of immersing fowls in these dips is sometimes rather alarming, the birds lying

Construction of a new fowl house in a tick area.

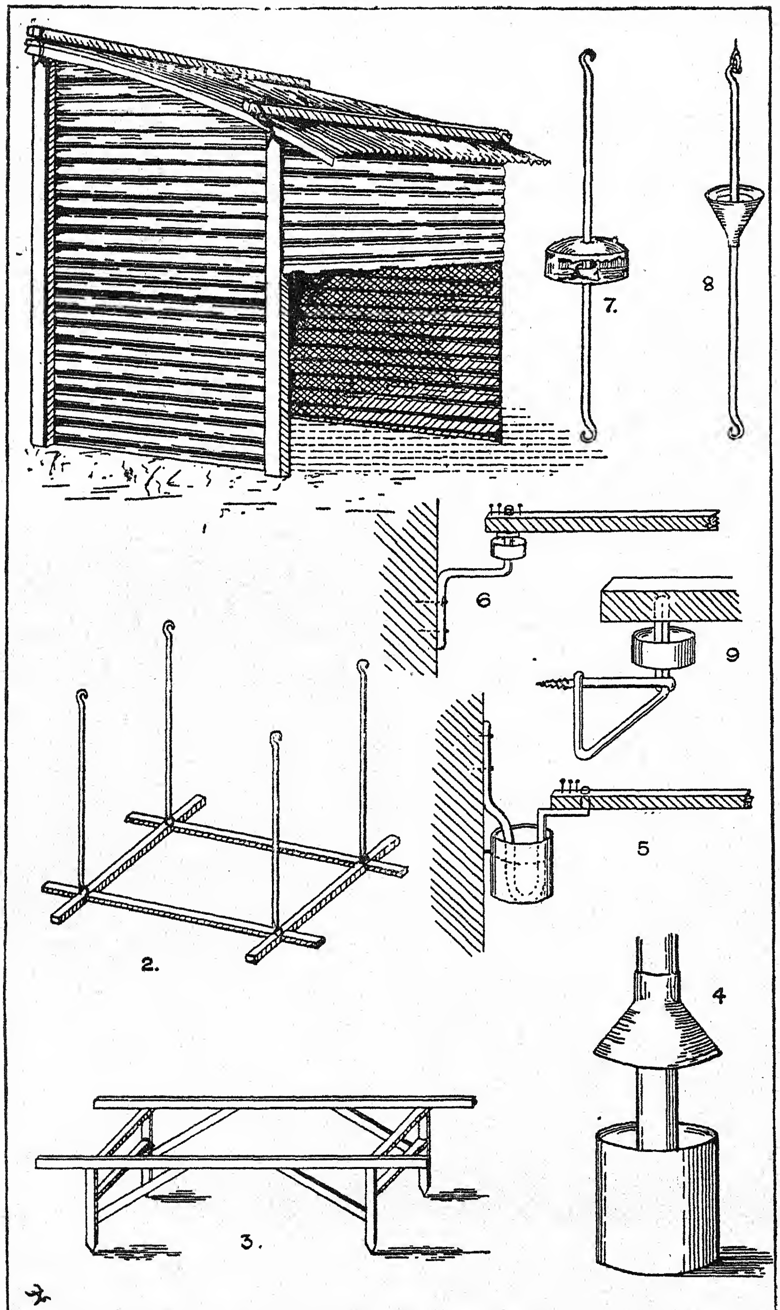


FIG. 7.—1. Tick-proof Fowl House with woodwork outside. 2. One level roost to show how supported by rods or wires. 3. One level roost supported from floor. 4. Suggestion for insulating leg of No. 3. 5 and 6. Methods of insulating roosts by tick-proof wall brackets. 7 and 8. Insulation devices for rods and wires; in 7 which is dust-proof (figured with part of side cut away to show oil furrow) the oil is poured in through the aperture at the top. 9. Tick-proof roost bracket procurable from dealers in poultry supplies. (After Lounsbury.)

on their sides as if about to die; they quickly recover, however, and if care is taken, fatalities are rare. The natives of India use "Bindal" in decoction, 2 ounces to the quart of water. The fowls are dipped in this, but it is better to apply it with a brush.

It is important to avoid the introduction of ticks into runs which are free, and for this purpose it is very advisable to isolate new fowls for ten days and to destroy any ticks found on them before allowing them to go into the run. The boxes in which they are isolated should be thoroughly disinfected to destroy the larvæ which will leave the fowl in this time.

Lounsbury gives the following advice and the accompanying diagrams on the above subject. The one great aim is to have the building as nearly tick-proof as possible. Corrugated iron is one of the best building materials for this purpose. A design with all the wood work outside was figured by Mr. Alex. Crawford, in the Journal of the Western Australia Department of Agriculture for June 1902 (see Fig. 7). Four upright posts support the structure. Strips of corrugated iron placed crosswise form the front, back and sides. Those forming the ends are screwed to the inside of the posts, and those forming the back and front to the outsides. The lower half of the front is left open, but a sheet of iron, hinged at the upper side to admit of closing it at night could be easily added; likewise a sheet at the back could be made to open outwards on hinges, so that the egg boxes could be inspected from without. The sheets to form the roof are laid in position, and then held down by two battens, one at the back and the other at the front, bound by wire to the corner uprights. The outsides of the house should be painted with refrigerating white paint, and the inside with tar. Great cleanliness of the house and run is necessary.

Treatment of the sick.—There is no reliable treatment.

MANAGEMENT OF EXPERIMENT STATIONS IN INDIA.

By B. P. STANDEN, C.I.E., I.C.S.,

Director of Agriculture, Central Provinces.

This article deals briefly with one feature in the management of experiment stations of some importance from several points of view. It is scarcely necessary to say that the object of an experiment station is not to make a profit, but to solve certain problems of sufficient importance to warrant the expenditure of public money. But the influence of this principle, coupled with a praiseworthy desire that the appearance of the station should be worthy of its owner, has caused us to forget that it is possible to pay too little attention to earnings and even to prejudice the results of the experiment work by unnecessary elaboration of arrangements, and to ignore that what is applicable to an establishment intended for experiment only, does not necessarily apply to farms used for other purposes besides the investigation of agricultural problems. Many, perhaps the majority of the experiment stations in India, comprise much larger areas than are required for the conduct of the experiments; they usually cover 150 or 200 acres, of which only some 15 or 20 acres are used for experimental purposes, the remainder of the area growing good varieties of crops for seed. Such a station is, in fact, a highly cultivated farm, of which a small part is set aside for purposes not directly profitable, and which is managed by a staff which is more expensive than would be required for a farm of similar size cultivated for profit only. The station is provided with good buildings, comprising quarters for the establishment, seed store, barns for storing fodder, and cattle sheds with special arrangements for collecting and storing the urine and dung of the cattle.

The cattle are the best to be had. The first thing which strikes a cultivator who visits a station fitted up in this way is the enormous cost of the arrangements; he at once draws the conclusion that, if the crops are better than he can raise, it is due to lavish expenditure beyond his means. He sometimes doubts whether even the fine crops which he sees on the ground will pay for the expenditure which he incurs, and if he asks for information, he is told that there is a large loss on the station and that it is not intended that it should pay. This sends him away with a very natural, though a wrong, idea of the value of the work that is being done. This idea may be modified in particulars by demonstration of novel operations in his own village under normal conditions. Such demonstrations may be, and indeed have been, effective so far as regards particular operations, but they do not suffice to remove the impression produced by a visit to the station that high farming on the whole is not profitable. This is unfortunate because, although very much can be done to increase the produce of the country by the introduction of new methods, the more thorough application of practices now in common use is also of the utmost importance, and it should be our object to stimulate the cultivator by showing him that the mere exercise of the utmost care and diligence in all ordinary operations is productive of great advantage. There is even a danger that the perfection of the buildings, stock, etc., may diminish the practical value of the experimental work. For instance, it will be admitted that we are not working for the benefit of farmers who can afford to stand their cattle on stone floors with channels to lead off the urine into brick-lined and roofed pits in which the dung and refuse is stored. Yet our experiments are conducted only with manure produced under these conditions. The results of similar experiments carried out under conditions attainable by any good cultivator in India would certainly be different, and might conceivably affect the conclusions drawn.

The proposition which I would put forward is that, in designing an experiment station of the sort described above, it

should be borne in mind that after making allowance for staff and buildings required for the experimental part of the area, the value of the produce of such parts of the farm as are not used for experiment should be sufficient to cover the cost of management and cultivation, including interest and depreciation on cost of buildings and to yield a substantial profit besides. It is, of course, understood that the land would not be used for crops which for any reason could not be profitably grown on a large scale in the locality for the benefit of which the station is established. Since a part of the produce would often be distributed gratis, the actual cash receipts would not necessarily reach this figure. The acceptance of this principle would, no doubt, result in less perfect buildings than would be usually erected in Europe, by a rich landlord, but it must be recognised that agriculture cannot give the same returns in India as in Europe, because cattle are not kept for food, and the quantity of farm yard manure available must be much less, and is as a matter of fact extremely limited.

The accounts should be so drawn up as to show the amount of the expenditure which may fairly be taken against the non-experimental area and the value of the produce of that area. The division of the cost of superior establishment and buildings between experimental and non-experimental areas would be partly arbitrary, but the result would be sufficiently correct to afford an indication of the extent to which the principle stated in the last paragraph is being observed.

Accounts are not now kept so as to distinguish between expenditure debitable to experimental and non-experimental cultivation, but the deficit is in some cases at least so large as to leave no doubt that the receipts for the latter area are never likely to provide a margin of profit on the expenditure. In the most favourable instance known to me, a gross return of Rs. 60 per acre would be necessary on an area of 100 acres to cover the cost of cultivation and interest and depreciation. The present gross return is only Rs. 34 per acre. But although it may not be possible in all cases that the receipts should yield a fair profit on the sum spent in establishing the non-experimental part of

the station, it is at least certain that if the principle advocated in this note were definitely recognised, the net expenditure on the department could be materially reduced. If experiment stations can be safely managed on these lines without risk of sacrificing the objects of the station to profit-making, there seems as good reason for insisting on the production of a profit from the non-experimental area as on the production of useful results from the experimental series.

Note.—Mr. Standen's article raises questions which, in the interest of the Agricultural Department, I consider, are of very substantial importance. I should like criticisms, which I will gladly publish in the "Journal."—Editor.

REAPING MACHINES FOR WHEAT IN THE PUNJAB.

By S. MILLIGAN, M.A., B.SC.,

Deputy Director of Agriculture, Punjab.

Like all new countries, the Canal Colonies of the Punjab have suffered since their inception from a scarcity of labour. Cultivation has, hitherto, been extensive rather than intensive, at least judged from Indian standards; and while labour has been scarcely adequate for ordinary purposes, the pinch is severely felt at the wheat-harvest time, the floating population of casual labourers being quite insufficient for the requirements of the Colonies. This year, it is true, labour has been more plentiful than usual, but owing merely to the great shortage of the matured wheat-area of the Province. For some years, the average daily rate of harvest labour has been not less than Re. 1 per man, payable in kind, and the cost of reaping Rs. 5 per "killa".

It would thus appear that there was a fair opening for reaping machines, provided that they could be properly worked in the somewhat diverse conditions of the irrigated fields of the cultivators. In the Canal Colonies, each field is exactly one killa in area or $1\frac{1}{9}$ acres, and is usually sub-divided for irrigation purposes into four or six parts by bands or "kiaris" as they are called. The small size of the fields entailing many "openings" and the obstructions offered by the "kiaris" summarise the chief difficulties in machine reaping. The hardness of the land, while it increases vibration, considerably diminishes the draught and enables two-horse mowers and reapers to be drawn by moderately strong bullocks.

The question being of primary importance to the internal economy of the Canal Colonies has received the attention of the Agricultural Department for some years. There were really two main problems to solve.

1. The economic question as to whether the available labour supply would not be better employed in gathering and binding the crops cut by machines.

2. The selection of a suitable type of machine to overcome the difficulties above mentioned, simple enough to be managed by the ordinary zemindar and light enough in the draught for his ordinary bullocks. The Department having addressed itself to the question, several types of machines were put under trial; and while these trials were going on, observations were made as to the economic problem as to whether there was a chance of a reasonably good return on invested capital. Dealing with this point, it may be as well to mention that reaping in the Punjab usually means, in addition to the cutting of the corn, the binding of the cut crop into large bundles of about a maund (82 lbs.) each and the carrying of it to the threshing floor. The binding and removing of the crop is done by the reapers themselves, who stop cutting in the afternoon for the purpose. This practice had to be taken into consideration when making calculations as to the probable area which would be cut by a machine in the Districts, as it could not be hoped that the cultivators would at once abandon their traditional methods and adopt the more economic one of keeping all operations going at the same time. The following calculations, therefore, were based on that assumption. After some trials it was estimated that with a manual delivery reaper (the type finally chosen as being the simplest, lightest, and most suitable to local conditions), by employing a force of 8 men, 5 killas per day could be reasonably expected to be cut, bound and removed by ordinary cultivators, and that the extra labour employed in carrying out all operations at once would increase proportionally with the area cut. The saving in labour would, therefore, amount to the wages of $(5-1{\cdot}6) = 3{\cdot}4$ men per killa for all areas

cut. With an average of 14 days reaping, the annual area cut would amount to 70 killas. Annual expenses were estimated at Rs. 100 as under :—

	Rs.
Interest and depreciation on Rs. 250 at 30%	75
Repairs	15
Oil Rs. 5. Extra food for cattle Rs. 5.	10
	100

In order that the machine should pay its way, the saving in labour would thus have to exceed Rs. 100 per annum, and this would depend on the daily rate of wages. The profit and loss would, therefore, be represented by the value of 'y' in the equation.

Net gain. Killas. Men. Wages. Rs.

$$y = (70 \times 3{\cdot}4 \times X) - 100$$
$$= 238\,X - 100 \text{ Rs.}$$

where X equals the daily rate of wages in rupees. Giving X the values 0, $\frac{1}{4}$, $\frac{50}{119}$, $\frac{1}{2}$, $\frac{3}{4}$, and 1 in succession, we have the following values of Y or the annual profit after deducting interest and depreciations.

Daily rate of labour in Rs. X	or in As.	Annual profit in Rs. Y
Rs.		
0	0	−100
$\frac{1}{4}$	4	−40·5
$\frac{50}{119}$	6·7	......
$\frac{1}{2}$	8	+19
$\frac{3}{4}$	12	+78·5
1	16 etc.	+138

It will be seen that machine cutting would begin to pay when labour exceeds 6·7as. per day, and that the profit rises to Rs. 138 for Re. 1 per day, a figure below which it very rarely falls.

An examination of the variations of the profit and loss account under different areas cut per season is useful and important ; assuming that depreciation varies according to two factors, one half with the number of years in which the machine has been in use, and the other half directly with the actual area

cut, and taking Rs. 5 per killa as the average cost of reaping by sickle, the profit can be represented very nearly by the value of Y in the equation Y = (2·48 X − 35). Giving X the value of 5, 10, etc., in succession, we have—

Acres cut annually.	Profit and loss.
X	Y
Rs.	Rs.
5	−22·6
10	−10·2
14·1	...
15	2·2
40	64·2
70	138·6
100	213
150	337
200	561

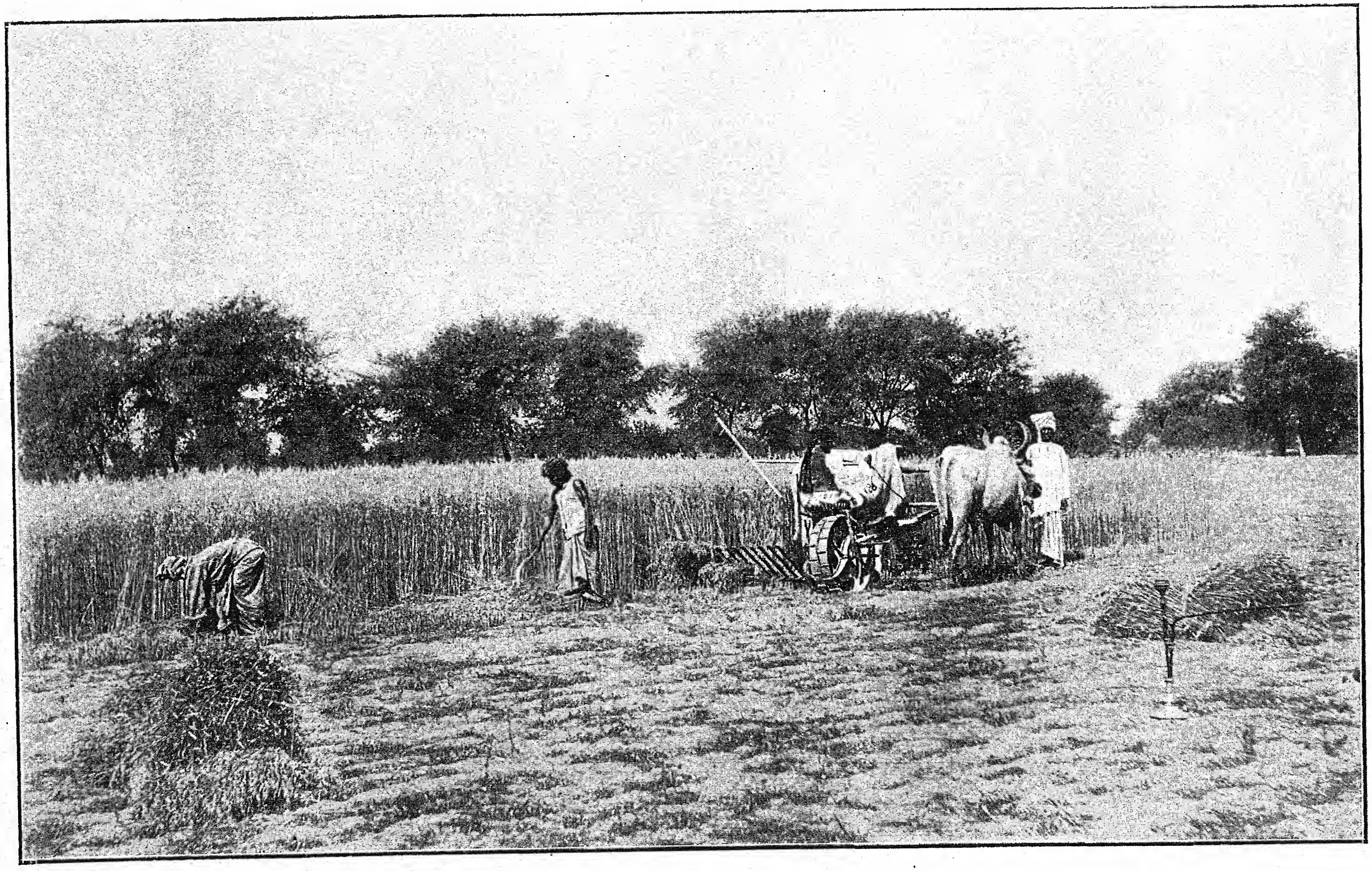
The following points may be noticed :—

Firstly.—That in ordinary years the machine will just begin to pay with an annual cutting of 14·1 acres. This is very important, as it would indicate that even in unfavourable years with lying crops there is not much fear of any man getting at least interest for his capital.

A more important point brought out is the great advantage of reaping large areas annually, while it is not to be expected that the ordinary zemindar owner of a machine will push its cutting capacity to its limits, the figures shown indicate a wide field for enterprising contractors. In the more protracted seasons, by proper organisation the figures 150 and 200 killas could be, I think, attained to. At any rate, the figures indicate the very great importance of the organisation of labour.

From the calculations given above, little doubt remained as to the economic value of reaping by machine even under the worst conditions, and the great possibilities under more favourable auspices. It only remained to obtain a suitable machine, and to see whether the average cultivator could work it successfully or not. After several trials, it was decided that a combined reaper and mower would prove the most reliable type as a pioneer machine. (Plate XLI.) The trials were watched with considerable interest by a few zemindars who were struck with the simplicity of the

PLATE XLI.



A. J. I.

REAPING WHEAT, LYALLPUR, PUNJAB.

manual delivery type, and orders for 22 of these machines were booked by private individuals for the harvest of 1908. Further indents for 30 more were sent in by District Boards and other bodies for demonstration purposes throughout the Province, the total thus amounting to 52, quite a sufficient number to give a fair indication as to whether the zemindar would be equal to the successful working of the innovation or not.

Prior to this year, several attempts had been made by private individuals to introduce reaping machines into the Colonies but these all ended in failure, mainly owing to the adoption of unsuitable types of machines and to want of perseverance. Preparations were made in good time by the Department to give some assistance to purchasers at the outset, and classes of practical instruction were instituted at Lyallpur before harvest time. Pamphlets giving directions for the use and care of machines were also circulated to purchasers; on account of the smallness of the Departmental staff, practical assistance during harvest time could only be given to a limited number of owners, and as the Lyallpur District contained all the private purchasers and by far the greater number of machines, it was decided to concentrate our efforts there. This course was justified by the results, as complete success attended the working of the machines in that District in spite of all difficulties. The machines did good work, proved to be of light enough draught for average bullocks, and, best of all, were after a few lessons understood by the zemindars themselves. The previous estimates for labour, etc., proved near the mark. The average area for the season worked out at a little over 68 killas or a little over 5 killas per day. The average saving in labour was nearly 3·3 men per killa as against an estimate of 3·4, the difference being due to bad organisation on the part of several users. Breakages were few, the cost of spare parts and repairs averaging Rs. 2 as against an estimate of Rs. 15, but of course the machines were new. The question of depreciation can only be satisfactorily settled after some years' experience, but all the Lyallpur District machines are in good order after the season's work.

The working of the machines in the other Districts was, on the whole, not so satisfactory, although some notable exceptions were recorded. The reasons are not far to seek. In the first place, the machines were used for demonstration only and no attempt was made to run them on commercial lines. Secondly, they were not bought by private individuals, and the first incentive to success, namely, profit, was absent. Again, there are many districts, especially those irrigated from wells, which are totally unfitted for machine reaping. Possibly, too, the personal help given at the outset by the Agricultural Staff in the Lyallpur District had not a little to do with the success attained there.

On the whole, the results are very encouraging, and it seems fairly well established that the adoption of machines of a suitable type will prove a success in the Canal Colonies. Considering the large areas under Canal irrigation, and the vast extension schemes projected by the Irrigation Department, there appears to be a very wide field for their use.

The Agricultural Department is making arrangements to establish an agency at Lyallpur for the sale, distribution and repair of machines, and will devote its attention towards effecting improvements in the machine itself and assisting in the education of zemindars in its proper use.

The great danger seems to lie in the introduction into the market of unsuitable types or machines of inferior workmanship, and local purchasers would be well advised to consult the Department before buying an unknown make of machine.

SOME FIBRE PLANTS OF UPPER BURMA.

BY LEON AUBERT, B.A., B.SC.,

Superintendent of Land Records, Burma.

FIBRE can be extracted, more or less, from a large variety of plants in Burma, but only a few are really valuable and of any use to the Burman agriculturist in the construction of his house or his carts, for repairs to his harrows or his ploughs, or for sale to his less industrious neighbours. Amongst these plants, *Hibiscus cannabinus* (in Burmese, *Chinbaung*), an annual commonly cultivated in Upper Burma for its fibre, holds the first place and makes at the same time an excellent pot-herb, as the tender leaves and green capsules are eaten in curry. Sown at the beginning of the rains in small patches or mixed with other vegetables such as pumpkins, gourds, or beans, it is uprooted or cut down close to its root in November. The area under this crop in Upper Burma can be safely estimated at 10,000 or 12,000 acres. It is also cultivated, to a certain extent, in parts of Lower Burma, but it is not as common as in the Upper Province. This is really the principal fibre plant of Upper Burma, where *Crotalaria retusa* and *Crotalaria juncea* (*Paiksan*) are not grown, except on the banks of the Irrawaddy and Sittang Rivers. The latter is cultivated in Lower Burma, and the fibre is utilized for making fishing nets.

Hibiscus cannabinus.

2. To extract the fibre of *Hibiscus cannabinus*, an incision is made all round the lower end of the stem of the grown up matured plant. The epidermis comes off readily, and the ligneous portion is thrown aside. Having separated the bark from the fibrous portion under it, the latter is dried in the sun for a couple of days and stored up. When required to be made into rope,

the fibrous mass is soaked for a week in water. At the end of that time, it is placed on a slab and beaten with a mallet to remove all the fleshy matter. A final washing leaves the pure fibre, which is placed in the sun, but not allowed to dry completely and is twisted into rope; if too dry, it should be moistened before twisting. Ropes can be made of any size and length required. An inferior kind of rope is made also with the epidermis which is not thrown aside, but utilized by agriculturists of the poorer class for binding the yokes of their ploughs and carts. (Plate XLII.)

Hibiscus furcatus.

Another hibiscus, *Hibiscus furcatus* (in Burmese, *Chin-baung yaing*) grows wild. The fibre is sometimes extracted and treated in the manner described for *Hibiscus cannabinus*, but is not valued.

Urena Lobata.

3. Though found in a wild state and common throughout the country, *Urena lobata* (in Burmese, *Ka-sihne*) may well be mentioned here. The fibre is used to make ropes, especially in Lower Burma, and the plant could be cultivated easily. The method of extraction is the same as in the case of *Hibiscus cannabinus*, and more or less trouble is taken according to the kind of rope required.

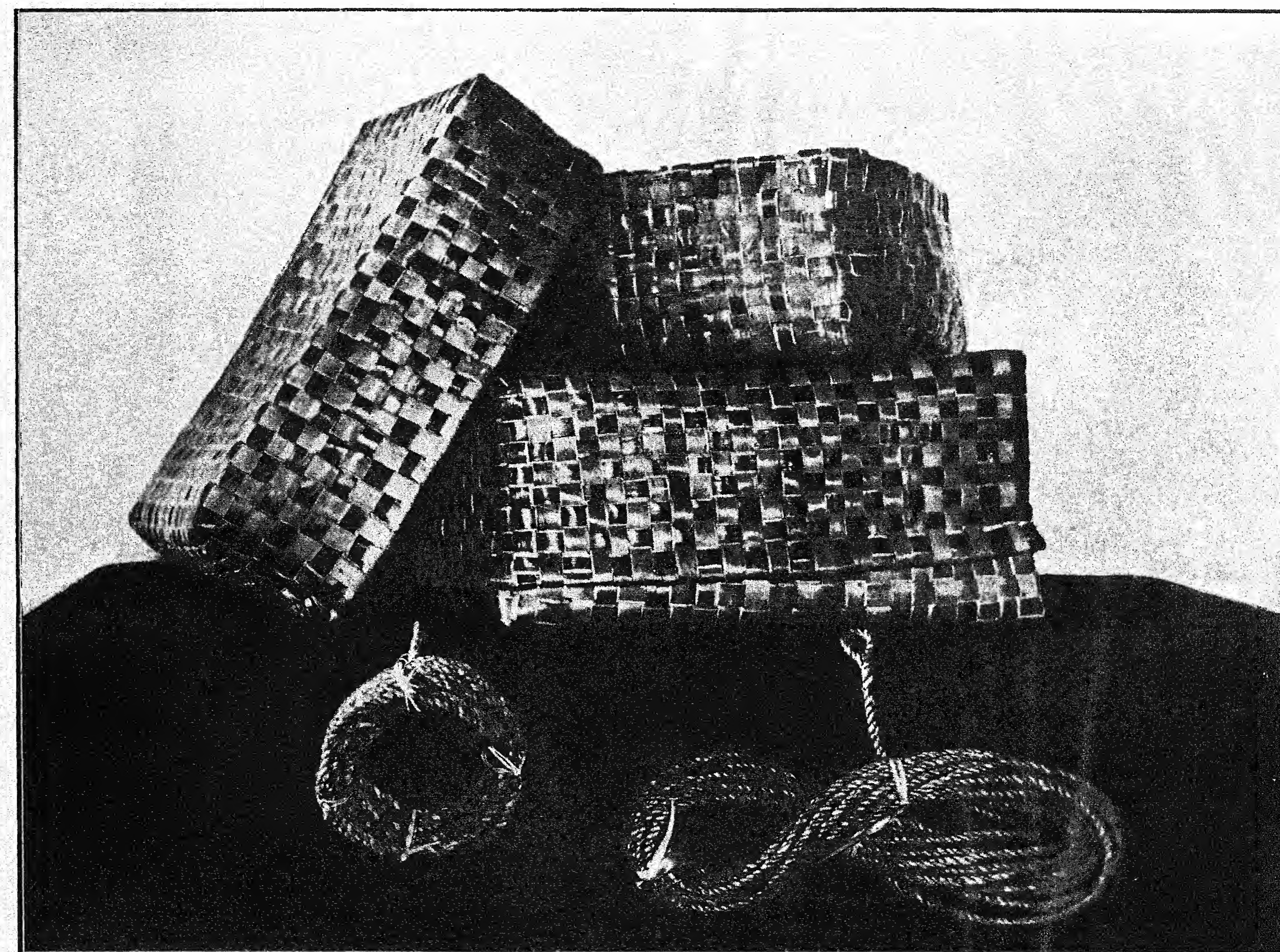
Bauhinia Racemosa.

4. *Bauhinia racemosa* (in Burmese, *Hpalanbin*), a large jungle tree, also supplies the agriculturist with a useful fibre. The process employed in its extraction is very similar to that followed in the case of the *Hibiscus*. The rope made with the bark is generally used during the rainy season and is said to improve in tenacity when exposed to moisture or to the effects of wet weather. This *Bauhinia* is not cultivated.

Agave Vera Cruz.

5. Another fibre plant evidently introduced from India or imported by the Portuguese and cultivated in days gone by, is *Agave Vera Cruz* (in Burmese, *Nanat*). This *agave* is not now, in these days of cheap Manchester cotton fabrics, cultivated for its fibre, but is often grown round villages and burial grounds as a live-fence. (Plate XLIII.) The plant is said to flower only once and die. At that time a long ligneous stem 18 to 20 feet high shoots up from the middle

PLATE XLII.



BURMESE PAHS.

of the plant carrying large cymes of flowers. This plant, named by the residents Aloe, Indian Aloe, American Aloe—but not an aloe at all—yields a good fibre which is extracted and utilized for rope-making by prison labour in several jails in Upper Burma. The process adopted here is the Indian method. The leaf is first beaten on a slab with a wooden mallet, soaked and washed in pure water, then beaten a second time and allowed to dry in the sun. After this, the dry fibrous mass is beaten a third time and made into rope.

The Burmese process, closely connected with the birth of the silk industry originally introduced into Burma from Arracan, Assam and China, is described by very old Burmans* as follows :—About the year 1860 (1222 Burmese era) during the reign of King Mindon, a colony of Arracanese silk-weavers (*Kathe*) established themselves in one of the southern quarters of Mandalay—the Naddi-yo quarter—and began to weave silk fabrics for the King and well-to-do people. For the use of the lower classes, a cheaper quality was woven with a mixture of this *Agave* fibre extracted by the process described hereafter. Though simple and primitive, this excellent method yields a beautiful, soft, shiny fibre in every appearance similar to silk. The *Agave* leaves are buried in putrid mud such as the mud, of old stagnant marshes for several days until all the fleshy cellular matter is entirely decayed. A fibrous mass remains which is beaten with a mallet, washed in clear water and dried in the sun. The white silky fibre thus obtained is said to have deceived even experienced Burmese silk weavers.

Dendrocalamus strictus.

6. Good rope is also made with the fibre of *Dendrocalamus strictus* (in Burmese, *Hmyinwa*), a bamboo which grows wild throughout Upper Burma in thick clumps 40 to 50 feet high. The full sized shoots only are used for this purpose. They appear at the beginning of the rains, in June. By November they have grown up to a

* This method has been described by U Sin of Kalaywa (Yamethin), formerly ex-Captain in the Burmese army during the reigns of Kings Mindon and Thibaw.

height of 30 or 40 feet and are clad with fresh leaves. This is now the time, before these shoots have passed their sixth or seventh month, to collect the fibre and store it up to be made into rope as required. Passed this time, they harden and become useless. Long strips of the epidermis of the stem, the topmost smooth surface, are collected to weave mats—the well known glossy bamboo mats of Burma—and also long strips of the fibrous portion immediately under; the latter for rope making. After a couple of days soaking in water, they are twisted into rope. This rope is certainly inferior to that made with the fibre of *Hibiscus cannabinus*. The young shoots, 6 inches to a foot high (in Burmese, *Hmyit*) which appear yearly at the beginning of the rains, are boiled or pickled. They make a dish much esteemed by the Burmese and during the season are sold in all village bazaars.

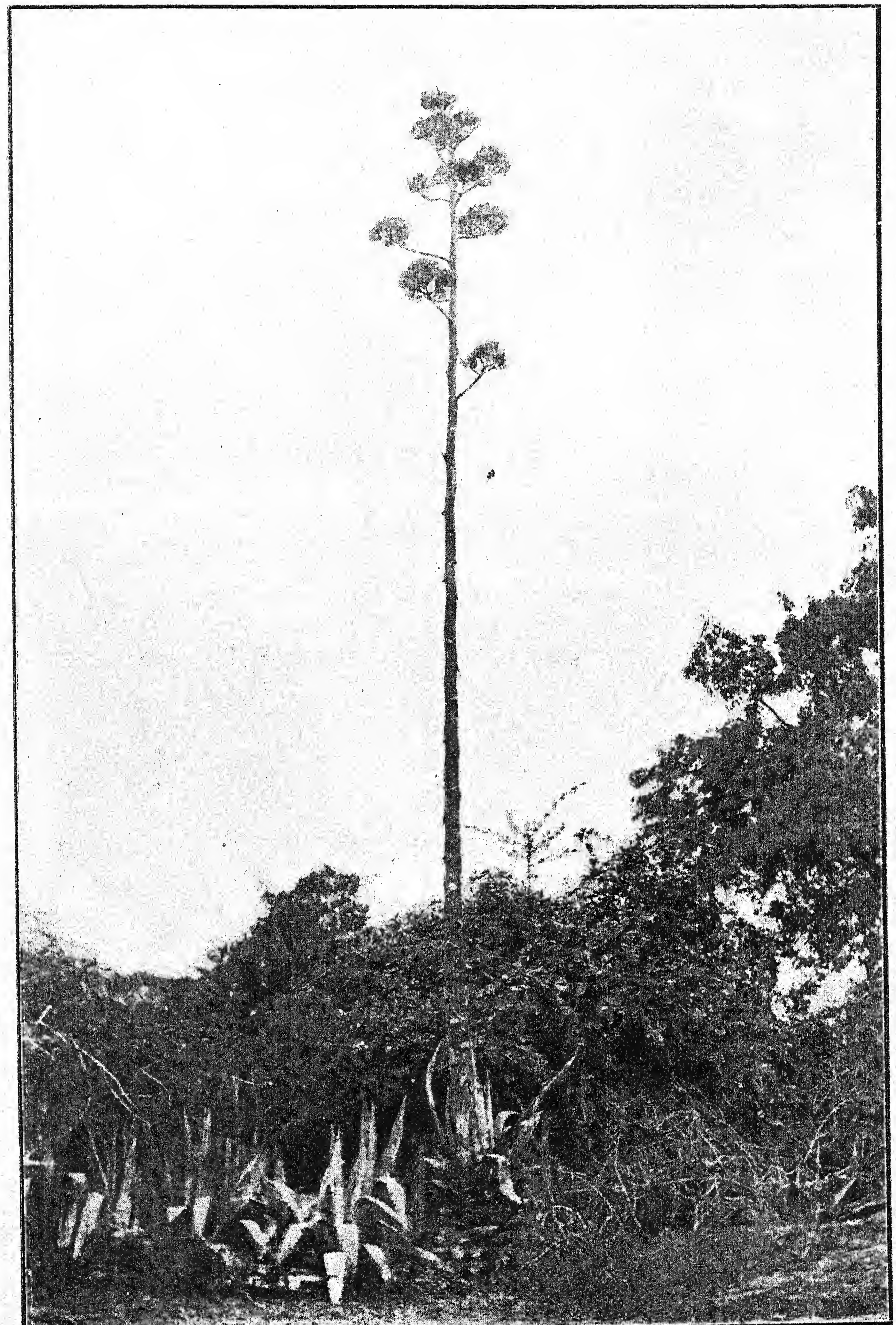
Corypha unbraculifera.

7. *Corypha unbraculifera* (in Burmese, *Pebin*) is a palmyra tree found throughout Burma and in Upper Burma especially, supplying a good fibre utilised for making ropes and cordages. This fibre is obtained from the tender new leaves found twisted and rolled up inside, the huge conspicuous terminal bud growing at the topmost part of the stem of the tree. This terminal leafy bud is taken, the tender new leaves inside are unrolled and the median nerve of each one extracted, thus leaving each leaf divided into two strips. Rope is made with a number of these strips according to the thickness required. Generally two strips are used for the ordinary sized rope. But ropes of this fibre are rare and found only in tracts where this tree abounds, as the extraction of the terminal bud for its fibre kills the tree. (Plate XLII.)

Borassus flabellifer.

8. The epidermis or external fibrous part of the petiole of the leaf in *Borassus flabellifer* (in Burmese, *Htanbin*), commonly known as the "toddy tree," is sometimes used for rope making. It is also with this epidermis, cut into thin equal strips of even width, that the useful and well-known "pahs"—rectangular shaped baskets with a lid or cover to fit—and those beautiful multi-

PLATE XLIII.



A. J. I.

AGAVE VERA CRUZ.

coloured mats, are generally skilfully woven. (Plate XLII.) The principal centres of manufacture are Pakokku and Myingyan in Upper Burma.

Cocos nucifera.

9. The pericarp or external envelope of the cocoanut fruit *Cocos nucifera* (in Burmese, *Onbin*) yields when dried a useful fibre—the coir (*onsan*), which requires soaking in water for a few days and beating with a mallet before it can be twisted into rope. Burmese agriculturists do not, as a rule, appreciate this rope, which they say is rough and would gall their bulls in no time. They prefer, with reason, the smooth rope made with the fibre of *Hibiscus cannabinus*. The coir ropes found in use locally are manufactured by jail labour in certain prisons in Burma or imported into the country from India.

The bark of certain hill forest trees supplies also a valuable material for the manufacture of ropes and cordages, which are exported chiefly by Chinese merchants to Rangoon, and thence to India or to the Straits ; but this fibre, too costly and out of his reach, is seldom used by the Burman agriculturist in the plains.

THE TRANSPLANTING OF RICE IN CHHATTISGARH.

By D. CLOUSTON, M.A., B.SC.,

Deputy Director of Agriculture, Central Provinces.

In the year 1906 there were 4,259,826 acres of rice in the Central Provinces and 28,027 acres in Berar, or a total area of 4,287,853 acres for these Provinces. Of this area 754,342 acres were transplanted and 3,533,511 acres broadcasted. Of the transplanted area 365,047 acres were irrigated, and 389,295 acres unirrigated. The chief rice-growing districts are Chanda, Bhandara and Balaghat in the Nagpur Division, and Raipur, Bilaspur and Drug in Chhattisgarh. In the Nagpur Division 68·4 per cent. of the total area under rice is transplanted; in Chhattisgarh with 2,830,074 acres, 37,878 acres or only 1·3 per cent. are transplanted and even this small area is confined to tracts bordering on the districts where transplanting is already in vogue. It is difficult to account satisfactorily for this important difference in agricultural practice between these two tracts, which are situated at no very great distance from each other and between which there is a good deal of inter-communication. Whilst the Wainganga valley districts consist of soil of crystalline formation, Chhattisgarh soil is mostly of laterite origin, but both seem equally suitable for transplanted rice. Want of knowledge or difference in the habits of the population can hardly account for the distinction. The most likely reason is that Chhattisgarh has hitherto had few facilities for irrigation, which is of more importance to transplanted than to broadcasted rice; but this difference is rapidly disappearing with the construction of irrigation works in Chhattisgarh. Chhattisgarh is the most backward agricultural tract in these Provinces, and the Chhattisgarhi is recognized as one of the laziest and least enterprising of cultivators. A large proportion of them are

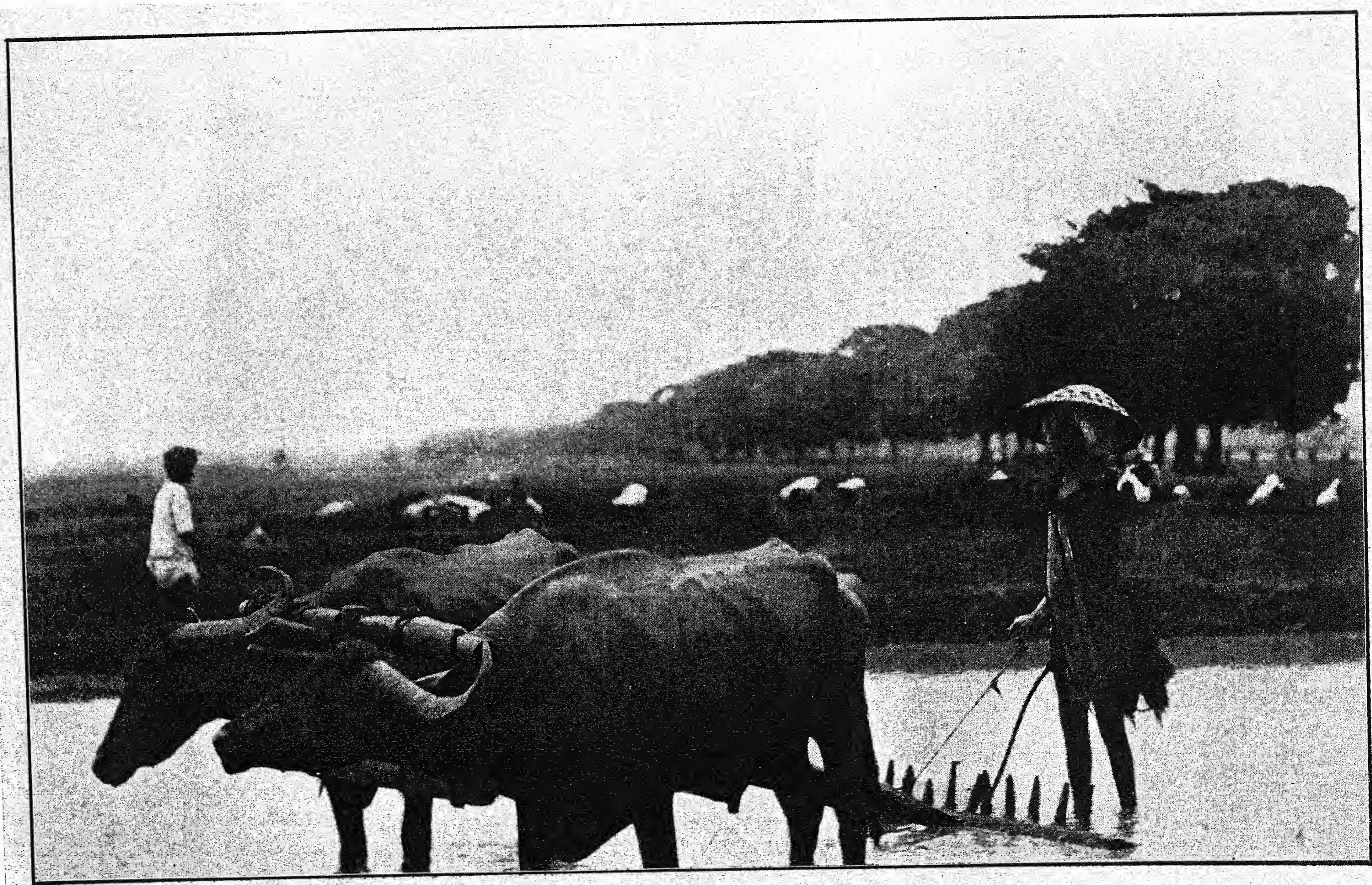
chamars by caste. As a race they are strong and hardy, make good farm servants if properly managed, but are quarrelsome and are much given to agrarian disputes.

The soils of this division are mostly of laterite origin. They may be divided into four distinct classes. The partially decomposed laterite rock of the higher lands, which gives a reddish gravelly soil, locally known as *bhata*, is the typical soil of large high-lying ridges covered with scrub and stunted grass, some of which bear at intervals a poor crop of the lesser millets (*Paspalum scrobiculatum* and *Panicum psilopodium*). The *bhata* grades gradually into *matasi*, a fine-grained yellow loam which is considered the ideal soil for paddy in this tract. *Matasi* like *bhata* is unsuitable for double-cropping on account of its tendency to harden after the rains into a brick-like mass, which it is almost impossible to reduce to a fine state of tilth by means of the cultural implements in use in this tract. Moreover, it does not retain moisture well. Dorsa, or *dorasa* (meaning two kinds), is a mixture of *matasi* and *kanhar ;* it is dark grey in colour, grows rice and rabi crops fairly well, and is therefore suitable for double-cropping. *Kanhar* is a dark loamy soil found at still lower levels ; it contains less sand, and if pure, no nodules of limestone ; it is very retentive of moisture. *Kanhar* is the best wheat-producing soil of the tract, but is not so good for rice, being too heavy. Dr. Leather's analysis of these soils is given below :—

	Matasi.	Dorsa Soil.	Kanhar Soil.
Insoluble silicates and sand ...	87·41	74·68	69·73
Ferric oxide	4·12	6·71	7·64
Alumina...	4·78	11·43	13·83
Lime	0·28	0·85	1·05
Magnesia	0·30	0·81	0·75
Potash	0·43	0·86	0·79
Soda	0·13	0·20	0·25
Phosphoric acid	0·02	0·02	0·02
Sulphuric acid	Very little.		
Carbonic acid	0·13	0·09	0·08
Organic matter and combined water ...	2·40	4·35	5·86
	100·00	100·00	100·00
Total Nitrogen	·053	·041	·036
Available phosphoric acid	·001	·001	·001
Ditto do. potash	·010	·011	·012
Equivalent to calcium carbonate ...	·30	·20	·14

The Raipur Experimental Farm is fairly representative of this grading of soils, ranging from *bhata* on the higher land outside the farm limits to the gently sloping fields of *matasi*, *dorsa* and *kanhar* of the farm itself. The *matasi* area is reserved solely for rice ; the *dorsa* for rice followed by pulses, or wheat as the sole crop of the year, and the *kanhar* for wheat and sugar-cane. The farm was established mainly with the view of solving problems relating to the cultivation of rice, the staple crop of the tract. One of the problems was to find the best method of sowing and after-cultivation. The methods practised in these provinces are transplanting, *biasi*, broadcasting and *lehi*. As practised in the Raipur Farm transplanting is carried out as follows : High-lying plots, where water does not collect, are selected as seed-beds, the whole rice area being divided up into 1/10th acre plots which are embanked with bunds $1\frac{1}{2}$ feet high. The bunds were constructed five years ago, and have so far required very little repairs. The area of the plots selected for seed-beds is 1/10th that of the area to be transplanted. The seed-beds are ploughed by the country plough, soon after the removal of the previous year's crop, when the soil is moist after the winter showers. The plots are then twice harrowed in April or May, manured with cattle dung at the rate of about 5 tons to the acre in June, and again harrowed after the first shower of the rains. Seed is broadcasted at the rate of 200 lbs. per acre. The seed may be sown before the outbreak of the rains if the land is sufficiently free from weeds. The seedlings are ready in from three to four weeks, the time depending largely on the quantity and quality of the manure used. The plots to which the seedlings are to be transplanted are ploughed once in the dry weather. In the beginning of the rains when the soil is sufficiently saturated with moisture, the plots are again ploughed and cross-ploughed by the country plough, and finally puddled by means of the *datari*, *i.e.*, a 6-foot beam fitted with harrow teeth. If the field is uneven, mud is dragged down from the higher to the lower ground by means of the same implement turned upside down, and then called a *kopar* or *mai*. The process of levelling with the *kopar* is shown below. (Plate XLIV.)

PLATE XLIV.



A. J. I.

LEVELLING WITH THE *Kopar*.

Buffaloes are mostly used for rice cultivation, because they are stronger than bullocks and take kindly to wet work of this kind. In Chhattisgarh no nose strings are used for working cattle, but by a dexterous use of the goad, and cries of ar-r-r-r-, hra-ha-ha-ha, etc., which to the uninitiated are meaningless enough; the ploughman manipulates his animals with considerable skill within the small area circumscribed by the bunds of the rice plots. When the soil of the plot has all been reduced to a creamy consistency (of wet mud), the plot is considered ready for transplanting. The seedlings, which are, when ready for transplantation about one foot high, are uprooted, the worker resting on one knee in the muddy water while doing so. Each handful is tied into a small bundle and placed on a *khirri* or sledge, which is dragged to the plots in which the seedlings are to be transplanted. The *khirri* is so shaped as to run easily over the rice bunds.

The bundles are scattered equally over the plot to be transplanted, so as to be within easy reach of the labourers as they move backwards. The root and lower part of the stem of each seedling is pushed into the soft mud to a depth of one or two inches and at distances of six or nine inches apart. The plants take root in a week, at the end of which time blanks are filled up. By planting only one seedling to the hole the seed rate is about 20lbs. per acre. At this rate the seed-bed will suffice to transplant ten times its own area. In some districts where transplanting is widely practised, the seedlings are planted out in bunches containing from two to five plants, and the seed rate per acre is about 80lbs. One seedling per hole is the standard adopted both on the Experimental and Demonstration Farms. One woman can transplant 1-10th acre in one day of ten hours when seedlings are brought to her. In most parts of Bhandara and Balaghat the method of transplanting is different, the bunches of seedlings being simply thrown into the mud while the worker moves backward. The time spent in pushing the seedlings into the mud is thus saved, and the work is done much faster. This method, however, is open to objection. The seedlings not being fixed in the mud, it sometimes happens that

they are washed away by a heavy rain before they have time to take root. A long break in the rains just after transplanting may prove equally injurious, many of the young plants being killed by the drought before they have time to take firm root. The method now being introduced into Chhattisgarh is open to neither of these objections, and is practised by the very best rice-growers in the best rice districts. It requires more time, but reduces to a minimum the risk of injury to the young seedlings from too much or too little water. The work of transplanting as practised in the Raipur Farm is shown below (Plates XLV and XLVI). As a protection from the rains many of the workers wear a large *topi* made of leaves.

Of transplanting in Balaghat where rice cultivation is more skilfully carried out than anywhere else in the Central Provinces, Mr. C. E. Low, I.C.S., Deputy Commissioner, writes :—"Transplanting is the system usually pursued ; it is said to give a larger outturn and grain of superior quality and flavour, and to be indispensable for the best kinds of rice. Broadcasting is usually practised in black soil where transplanting is more difficult than in light soil, and where early ripening varieties are sown to enable a second crop to be reaped. It is also adopted when a season of short rainfall is feared, or when the skill or resources of the tenants are not equal to transplantation ; this is often the case with aboriginal cultivators in jungly tracts. For transplanting, the nursery is sown by the usual method adopted for all Kharif crops. Before sowing it is cultivated twice with a *nagar* or narrow-bladed plough. A scarifier or *bakhar* is not used in light soil till a plough has twice been over the ground, so that the scarifier is not used for rice nurseries unless the land has been already ploughed up by the plough in the cold or hot weather. The manure consists of cow-dung, and before the application of this, straw, and, near the jungle, twigs and branches are often spread over the nursery and burned. (*Saj Terminalia tomentosa* is the favourite tree for this.) When the rain falls, this is ploughed into the ground, and the *datari* or harrow worked over the land to break up the clods. Seven or eight cartloads per half acre of nursery is considered a full manuring. Malguzars

PLATE XLV.

A. J. I.

TRANSPLANTING AS PRACTISED IN THE RAIPUR FARM.

with a large home-farm have to start their manuring a month or so before the rains break. Manure is not always, or even usually, given to any part of the field besides the nursery. For transplanting the seed rate is about 85lbs. per acre. A transplanted field can be easily told even after reaping, as the plants tiller far more than if sown broadcast, and the ground is more free from weeds. The nursery, after ploughing, manuring and clod crushing, is completed, is cleaned of weeds by women with sickles. The seedlings in 20 or 25 days grow to a foot in height, when they are fit for transplanting. Meantime the remaining area is ploughed again and left for a week. The *(datari)* harrow is used to break up clods, for which purpose it is turned upside down. The plough and the harrow are used twice each, by which time the surface consists of a smooth and creamy mud. Heavy rain just before transplantation spoils the consistency of the mud, and it has to be ploughed up again. The seedlings are uprooted from the nursery and stuck into the mud in bunches of about three or five; they lie flat for a day or two and then stand upright, except where there is very heavy rainfall, when they lie and rot: *gara kha gaye* (the mud has eaten it) says the unfortunate cultivator. The crop later in the season looks miserably stunted and is scarcely in ears; while surrounding fields contain a full crop. The seedlings are carried in head-loads in the case of small tenants, but on a *khirri* or sledge drawn by buffaloes, where cultivation is more extensive. If things go well, the transplanting for the district should be over in a month. The daily wages for transplantation are said to have risen from one anna before the 1896 famine to $1\frac{1}{2}$ anna in 1905. The above methods, which in the best villages are conjoined with very careful seed selection, are not susceptible of much improvement. It is, however, likely that the seed rate could be considerably lowered, if the area outside the nursery were well manured and the seedlings were transplanted singly, instead of three to five at a time. The seed rate on the Government farms where this is done is less than half that described above."

Biasi is the method widely practised in Chhattisgarh. The land is ploughed once before sowing. The seed is broadcasted

at the rate of about 100 lbs. per acre. When the plants are about one foot high, the land is ploughed, which uproots many of the plants and covers some with mud. This process as commonly practised in Chhattisgarh is shown below (Plate XLVII).

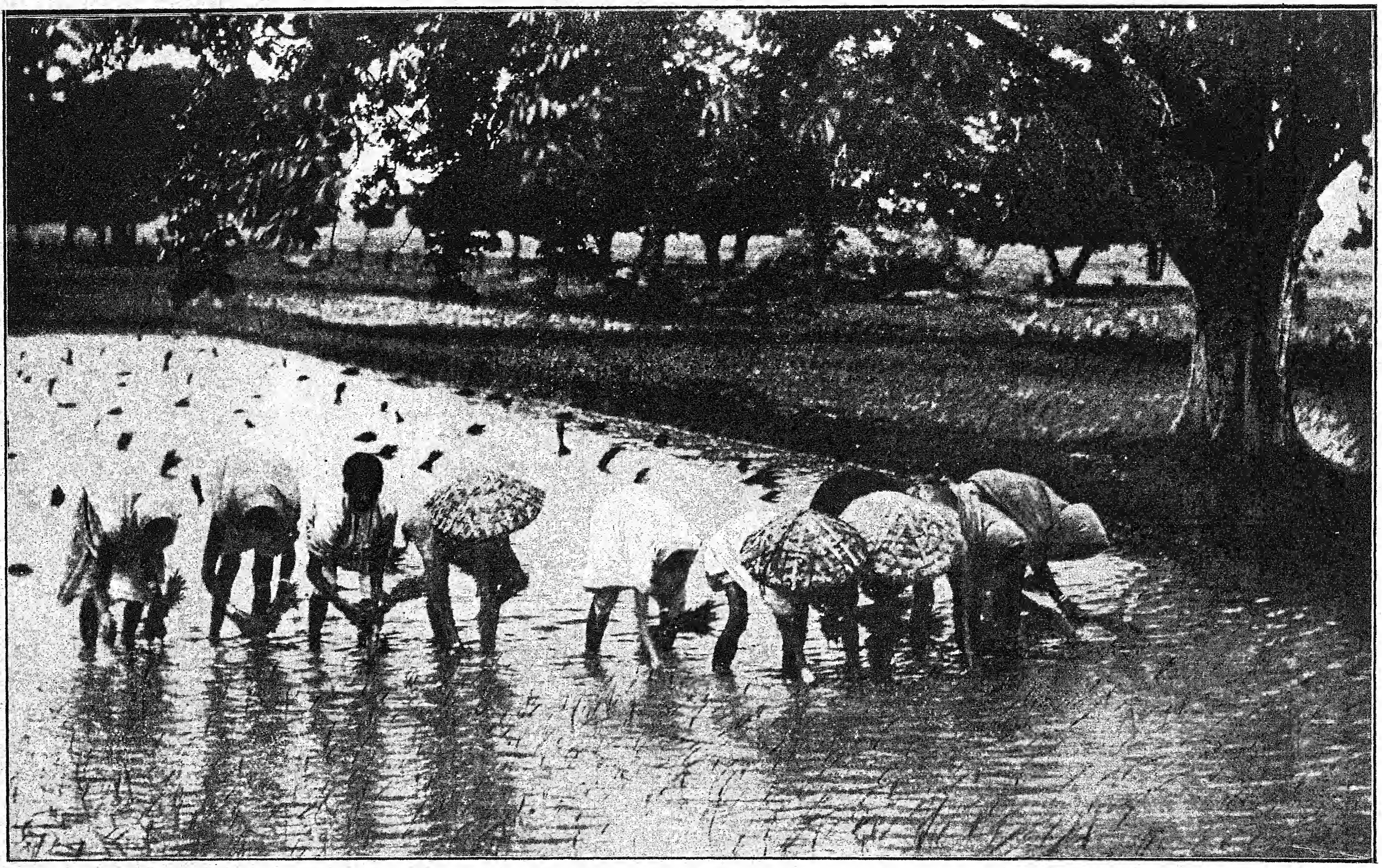
This rough-and-ready process thins out the plants and strengthens the root-growth of those that are left. Five or six days later the plot is levelled by means of the *kopar*, which flattens all the surviving plants in the mud. In five or six days more weeding operations are commenced ; two or three weedings at intervals of about a fortnight are generally necessary.

Broadcasting is the easiest and cheapest of all the methods in vogue. It is similar to *biasi*, but the seed is allowed to grow as it is sown ; there is no thinning out of the plants. In its crudest form as practised in some of the Native States in Chhattisgarh, the land is ploughed at the beginning of the rains, the seed sown broadcast and covered by means of the *kopar*, and the crop is left untouched till it is ready for harvesting. As a broadcasted field ripens earlier than a transplanted one, broadcasting is generally practised in high-lying fields which are less retentive of moisture and where, for that reason, the earlier maturing rices only can be grown. This method is an alternative to transplanting in Bhandara and Balaghat.

By the *lehi* or *koorah* method the seed is steeped before sowing so as to hasten germination ; otherwise, the method is the same as broadcasting. This method is practised in the Nagpur Division and parts of Chhattisgarh, and to the greatest extent in years in which the sowing has been delayed by heavy and continuous rain. In Jubbulpore and Damoh under the name of *Machhawa*, it is the method commonly followed in the best rice soils.

On the Raipur farm these four methods are being tested in series A and B of the Experimental programme, A being irrigated and B unirrigated. Both series of plots are uniformly manured with cattle-dung at the rate of 20 lbs. of nitrogen per acre ; the soil of the two series is *matasi*. The plots are each one-tenth of an acre in area. The paddy grown is *Parewa*, a medium variety. The results obtained are given in the statements following.

PLATE XLVI.



TRANSPLANTING AS PRACTISED IN THE RAIPUR FARM.

Plot.	Unirrigated :—Outturn per acre in lbs.												Average value of outturn.	Cost of cultivation, manure, &c.	Average profit, loss due to each method.
	1904-05.			1905-06.			1906-07.			1907-08.					
	Grain.	Straw.	Value.	Grain.	Straw.	Value.	Grain.	Straw.	Value.	Grain.	Straw.	Value			
			Rs.			Rs.			Rs.			Rs.	Rs. A.	Rs. A.	Rs. A.
I. Transplanted ...	1,940	1,440	49	1,630	1,050	48	1,840	1,340	41	1,080	1,130	46	46 0	8 14	37 2
II. Biasi ...	1,450	1,000	36	430	340	13	1,600	1,240	39	710	780	30	29 8	10 2	19 6
III. Broadcasted ...	750	640	19	740	580	22	1,240	690	29	750	890	32	25 8	6 14	18 10
IV. Lehi ...	930	1,010	24	470	410	14	790	570	19	270	280	11	17 0	10 7	6 9

Plot.	Irrigated :—Outturn per acre in lbs.												Average value from 1904-07.	Cost of cultivation, manure, and irrigation.	Average profit, loss due to each method.
	1904-05.			1905-06.			1906-07.			1907-08.					
	Grain.	Straw.	Value.	Grain.	Straw.	Value.	Grain.	Straw.	Value.	Grain.	Straw.	Value.			
I. Transplanted ...	2,000	1,560	Rs. 47	1,940	1,220	Rs. 54	1,940	1,430	Rs. 47	1,550	1,480	Rs. 66	Rs. A. 54 8	Rs. A. 10 12	Rs. A. 43 12
II. Biasi ...	1,670	1,070	40	1,610	1,160	49	1,240	1,150	30	1,140	1,120	48	41 12	12 0	29 12
III. Broadcasted ...	960	700	24	1,190	970	36	1,220	1,410	31	1,120	1,180	48	34 12	8 12	26 0
IV. Lehi ...	770	1,270	22	1,120	860	34	730	690	17	980	970	41	28 8	12 5	16 3

PLOUGHING THE LAND.

Transplanting without irrigation has increased the value of the yield by Rs. 17-12 per acre. Irrigation alone has raised the value of the yield by Rs. 10-6, even with *biasi*. When transplanting and irrigation are carried out together, the monetary value of the increase when compared with the Chhattisgarh method of *biasi* sowing without irrigation is Rs. 24-6 per acre.

The conclusions in brief to be drawn from these results as far as they apply to this division are : (1) that transplanting is a most profitable method even without irrigation where medium paddy is grown; (2) if the Chhattisgarhi will but irrigate his *biasi* paddy, he can increase the value of his crop by over Rs. 10-6 per acre; and (3) by adopting transplanting with irrigation, he can increase his profits by Rs. 24-6 per acre.

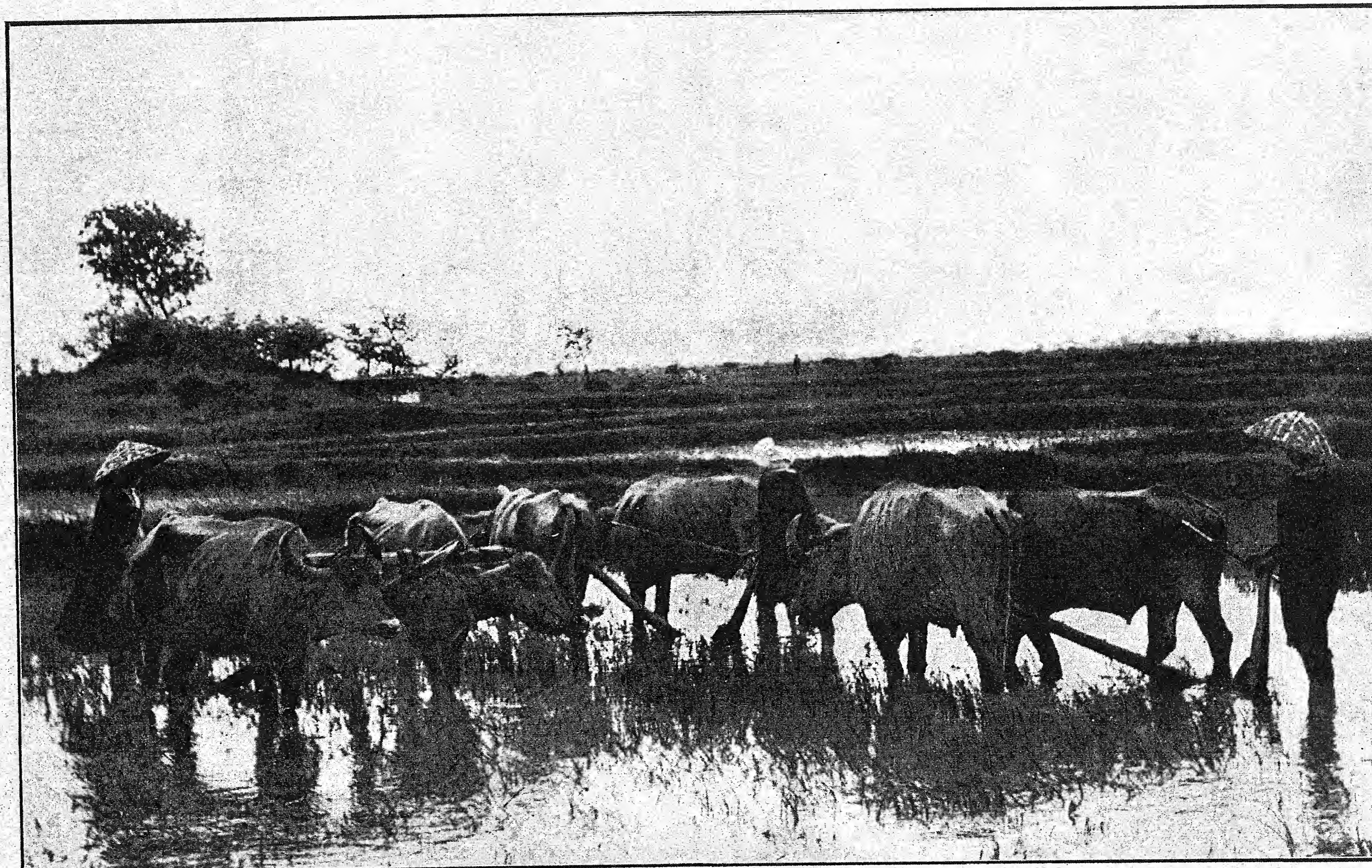
The water-supply on the Raipur station has so far been very inadequate, and for that reason late-ripening paddy has not yet been tried in these series. With a late heavy-yielding paddy and an adequate water-supply, the results would have been still more favourable. This is at least indicated by the outturns obtained on the demonstration farms last year, where *Gurmatia*, a late paddy grown in this division, was sown.

The results were as shown below :—

	OUTTURN OF PADDY IN LBS. PER ACRE.			VALUE OF INCREASES DUE TO TRANSPLANTING.			
	Transplanted by the Department.	Biasi by Cultivators.	Increase due to transplanting.	In year of normal rainfall.		1908.	
				Rs.	A.	Rs.	A.
Jageshwar Farm ...	3,940	2,450	1,490	35	7	49	11
Jawarbhandha Farm ...	1,690	600	1,090	25	15	36	5
Kolar Farm ...	2,880	1,272	1,608	38	5	53	9

The transplanted plots of the department and the *biasi* plots of the cultivators were manured alike and irrigated alike, so that the difference in the outturns is due to the superiority of this new method of sowing introduced. The result appeared all the more striking to the village cultivators, because the department

PLATE XLVII.



A. J. I.

PLOUGHING THE LAND.

only took over these demonstration plots about a fortnight before the rains, and no manure was applied save that which had been added by the ryot himself. He followed the example set to him by the demonstration farms and irrigated his rice this year for the first time. Even the primitive mind of the chamar could not fail to see that under these circumstances the increase in the outturn must have been due to the one varying factor, *viz.*, the method of sowing. As a cultivator, he could not help seeing that on the demonstration plot the *Sircar* (Government) produced a better crop than his own by means that were at his disposal.

In his inspection note on these farms Mr. F. G. Sly, I.C.S., Director of Agriculture, writes : "It has been fairly demonstrated that the outturn of rice can be very largely increased, indeed, almost doubled, by adopting transplanting instead of *biasi.* All the villagers frankly agreed to this conclusion, and have been evidently much impressed with this demonstration. In discussing the matter with them, I found that most had decided to transplant some of their land next year. Two objections were put forward to a large extension of the practice. The first is that transplanting is more insistent in its demand for water at a particular time; but they agreed that this is no difficulty under good irrigation tanks. The second is that it demands a large supply of labour at the particular time of transplanting, although the total expense is smaller owing to saving of seed and to the avoidance of all weeding after transplanting. This objection has some force, but it is hardly likely to stand in the way of the adoption of such a profitable practice. A third objection is that the system is difficult in parts where the holdings are very much scattered (the survival of the *lakhabhata* system); but this should not militate much against a large increase in the transplanted area. So far as our experience goes both on the Government farm and on the demonstration plots, I cannot point to any strong reason why transplanting should not succeed and extend in Chhattisgarh ; although if this is the case, it is extraordinary why it should not have been introduced earlier, seeing that it is practised in the neighbouring districts of Balaghat

and Bhandara and to a very limited extent in Chhattisgarh itself." The introduction of transplanting in a paddy tract is an enormous boon in the increase in outturn due to this method of sowing. It is a means, too, of inducing the cultivator to irrigate his crop, as the department recommends that for the present transplanting should be restricted to irrigated areas where late paddies can be grown. The importance of irrigation alone to this tract can scarcely be estimated, for the Chhattisgarhi cultivator is more dependent on water than any other in these Provinces. In a year like that just past, irrigation for him meant a bumper crop, while the want of it meant a very poor yield, much suffering and the necessity of Government relief to tide him over a year of indigence. Despite these facts, the Irrigation Department has experienced very great difficulty in inducing the cultivators of this division to utilize the water of Government tanks, for that the Chhattisgarhi does not yet fully appreciate the value of water as a factor in increasing the yield of his crops, is evident from the fact that of 2,830,074 acres of rice in this division, only 23,528 acres were irrigated during 1907-08. It was clearly the duty of the Agricultural Department to take up this line of work in earnest, and these demonstration farms were therefore started *last year* (1907), mainly with the view of getting this backward class of cultivators to incorporate into the general farm practice of their villages, the results of the work done at the Raipur station, by transplanting and irrigating their staple crop.

Demonstration work has so far been beset with many difficulties, and has in the past been the least successful of all the lines of work undertaken by the Agricultural Department. The success of the work last year was due to the following reasons :—(1) that it was undertaken and carried through with a definite aim; (2) that the department only attempted to demonstrate methods which had been clearly proved by experiment at the Raipur experimental station to be practicable and profitable; (3) that the work was carefully supervised; and (4) that the cultivators were made to feel that the work was done solely in their interests.

Other steps taken to popularise this method may be described. Cultivators are encouraged to inspect the Raipur Experimental farm and see for themselves the results obtained from transplanting there; this farm was visited last year by 4,203 visitors. All the meetings of the Raipur District Agricultural Association are held on the farm, and the members are shown plots of transplanted and *biasi* rice growing side by side, which is an object lesson that appeals to all. A statement of the results obtained from transplanted and *biasi* plots, respectively, on the experimental and demonstration farms, is prepared in the vernacular on large cardboard sheets, and the results explained at meetings of the Agricultural Association and at fairs. Short articles on the same have appeared in the vernacular editions of the *Agricultural Gazette*, published by this department; and finally, transplanting was demonstrated last year on the demonstration farms.

As a result of these methods of bringing the advantages of transplanting to the notice of cultivators, it was felt this year that the time had come to induce cultivators to attempt this important improvement on a large scale in their villages.

Last year the object aimed at was to make the demonstration farms a thorough success and to gain the good-will and confidence of the villagers. With this end in view the department supplied both bullocks and seed, and care was taken to see that the agricultural Assistants did not worry the visitors by requests for supplies. It was found necessary, however, to promise the cultivators concerned, that if the crop of the demonstration farms proved a bumper one, they would get all the produce, while if it was only a medium crop, the department would recoup itself by demanding one half of the same. This condition proved most effective in preventing the owners of the crops from allowing their cattle to graze at night in the rice fields, which is a common practice in Chhattisgarh, and which threatened at first to interfere very seriously with our work owing to the injury done to the nursery beds.

The agricultural assistant in charge allowed such cultivators as expressed their willingness to transplant small areas to take

spare seedlings from the nursery plots of the demonstration farms. Cultivators from the neighbouring villages were encouraged to come and inspect the plots transplanted by the Department, and the names of those who promised to transplant this year, and the area to be transplanted by each were recorded. Before last year's crop was harvested, a rough estimate had been formed of the area to be transplanted this year, and nursery beds for the same were prepared during the dry weather. The villages were grouped into what we call demonstration centres, there being four or five villages in each. Each centre was under the charge of an agricultural Assistant, and a ploughman experienced in transplanting was placed under his orders in each village. In villages where the malguzar complained of shortage of working cattle, a pair of buffaloes was also sent to him. It was decided to supply the seed free of cost wherever necessary, for two reasons :—(1) because where the cultivators have not been accustomed to irrigate their rice, they grow early or medium varieties, which do not yield so well as the late variety, namely, Gurmatia, which is largely grown on the Raipur farm, and which is recognized as the best heavy-yielding paddy in Chhattisgarh ; and (2) free seed was to many an inducement to transplant, more especially to those who had fared badly owing to last year's scarcity. The villagers as a whole share equally in the work of ploughing and sowing the nursery plots, and each transplants his own fields with the seedlings taken from the nursery plots. The nursery plots are thus common property. This co-operation is carried still further when the seedlings are ready for transplanting, and it is no uncommon sight to see almost all the village ploughs at work in one field. In the case of the work being unnecessarily delayed, the malguzar is always appealed to by the agricultural Assistants in charge. In villages where the malguzar and tenants were well-to-do, they supplied their own seed. Of the area to be transplanted, the department has supplied seed for 550 acres ; while the cultivators are using their own seed for nearly 1,000 acres.

The one great difficulty experienced in carrying through this rather ambitious scheme of work has been that of supplying

competent agricultural Assistants to put in charge. Owing to the paucity of Assistants, it was found impossible to comply this year with all the demands made for assistance in introducing this new method. In the absence of trained men, the department has adopted a plan which promises to be successful in practice. Ploughmen experienced in transplanting have been obtained from districts that are more advanced in rice cultivation. These have been sent out together with a few Chamar ploughmen from the Raipur Farm, some being attached to demonstration centres where they work under the agricultural Assistant in charge, while others are employed in villages where they work under the direction of the malguzar, or other respectable cultivator at whose request they have been sent. With the assistance of such men the malguzars of certain villages are transplanting from 20 to 40 acres this year, and some of them are retaining the services of the ploughmen at their own cost. With very few exceptions these malguzars are members of the District Agricultural Associations. In many cases these ploughmen have proved more reliable than some of the agricultural Assistants who have been put in charge of this work. They are at least practical agriculturists and belong to the best farming centres, which is not true of many of our Assistants. As ploughmen they have been accustomed to hard work under the rather uncongenial conditions which characterise village life in a paddy tract, and readily adapt themselves to similar conditions when transferred to another district. Not so the Brahmin who, accustomed to the comforts of town life and the society of his own caste-fellows, finds life in a humble chamar village almost unbearable, and leaves his work to look after itself on the pretext of illness.

As ploughmen for this kind of work are not available in Chhattisgarh itself, arrangements have been made to train boys in transplanting on the Raipur Farm. Twelve orphan boys varying in age from 13 to 19, have already completed their training there this year, and will be employed in future, either by the Missions to which they belong or by the Department of

Agriculture, in introducing this method among cultivators. Next year a new batch will be trained, and members of the Agricultural Associations and others interested in the work will also be asked to send men to undergo this training.

That this piece of demonstration work has produced results beyond all expectation, that a great amount of work has been accomplished this year with a very small trained staff, and that even the chamar cultivators have learnt a most useful lesson from it, is amply proved by the fact that this year with five Assistants and twenty-four ploughmen experienced in transplanting, the Department is transplanting about 1,300 acres scattered over 39 villages. In addition to this the members of the Agricultural Associations, to whom assistance could not be given this year, have agreed to transplant in all about 250 acres.

The success of this piece of work is due in no small measure to the very effective supervision exercised over it by the Superintendent of the Raipur farm; for in these Provinces the policy of the Agricultural Department is to put the Superintendent of the experimental station of each division in charge of the demonstration work of the same. This answers admirably, where the Superintendent is a sound practical man. The experimental work and demonstration work form parts of one great scheme; the one is incomplete without the other. If separate Assistants were made responsible for the different parts of that scheme, there would be less efficiency and much less work done per man. With one Superintendent for both, cultivators are made to feel that the demonstration farms are but off-shoots of the experimental farm, the one difference being that the former demonstrates only, while the latter experiments and demonstrates. The Superintendent inspects each centre once a month. The Assistants in charge of the different centres forward weekly diaries to the Deputy Director through the Superintendent. The Deputy Director inspects the different centres as often as possible.

This year's results show that the opinion held by many to the effect that the Chhattisgarhi is too lazy and unenterprising to adopt transplantation, that his bullocks are too weak for it and

his soils unsuitable, is at least open to doubt. Our experience of the chamar ploughmen at the Raipur farm is that they are very good workers when properly directed, though lacking in initiative. Judging from the large number of chamar cultivators who have this year come from neighbouring villages for seedlings, which they have uprooted for themselves and carried away in head loads for four or five miles, I am convinced that the term "lazy" is not applicable to them all. In any case it is the duty of the Agricultural Department not only to demonstrate improvements, but also to encourage, direct and otherwise assist the less enterprising cultivators to adopt them. That his soil is suitable for transplanting, there is no shadow of doubt.

That the weakness of the small Chhattisgarhi bullock will stand in the way of extensive cultivation of any kind is evident; still there are already in every village a few fairly good buffaloes and bullocks of sufficient strength to do all the extra work required for transplanting on a moderate scale even under existing conditions. Next year the Department intends to make the conditions still more favourable for transplanting by encouraging the cultivators to make a lighter *datari* specially for this work and by letting out buffaloes on hire to cultivators at the rate of one pair for each area of 50 acres to be transplanted.

In his inspection note on the work which is being carried out this year, Mr. B. P. Standen, I.C.S., C.I.E., Director of Agriculture, writes as follows :—

"There can be no doubt that transplantation has come to stay in Chhattisgarh. Nearly the whole of the 38,000 acres now transplanted in this division lies in the zamindaris situated in the hills and jungles to the south, east and west. I am told that a great deal of this so-called transplantation consists rather of thinning by hand than of transplantation proper. All cultivators who have witnessed the demonstrations have been deeply impressed by the great saving of seed and the large increase in the outturn. The difficulties to be overcome before the area transplanted will expand largely, are those mentioned in Mr. Sly's inspection note, together with the scarcity of strong plough

cattle and a rumour started by ill-disposed persons, that all transplanted land will be assessed to rent and revenue at a specially high rate. The Settlement Commissioner has promised to take steps to contradict this rumour, and, as the revenue of the greater part of Chhattisgarh is about to be fixed for 20 years, it is not likely to affect transplantation after the current year.

At present the demonstration plots are confined to irrigable land, and it is desirable not to urge transplantation at present on unirrigable land, although it is safely practised on large areas in the Wainganga valley, where the rainfall is somewhat higher (*vide* Mr. Clouston's, para 1). In that part of the country the rice bunds are generally higher and the fields hold more water than in Chhattisgarh, so that risk of damage by drought is less. When once well established in the irrigable lands of Chhattisgarh, the practice will be readily extended to dry areas. There is no reason to suppose that the labour difficulty offers any serious obstacle. Labour is more plentiful than in the Wainganga valley, but the transplanters naturally work very slowly : with practice they will complete their tasks in one-third or one-quarter of the time, and cultivators will find that they have ample leisure for weeding the *biasi* crop, after transplantation is completed. In connection with this part of the subject, it may be mentioned that although the cost of weeding a *biasi* crop properly is not less than that of transplanting rice on a similar area, the Chhattisgarhi very often weeds his crop very perfunctorily, securing no doubt a much smaller crop, but at the same time avoiding expenditure which he perhaps cannot afford without borrowing at a high rate of interest. To such a man the unavoidable expenditure on labour in transplanting is a serious consideration.

The want of a sufficient number of strong cattle seems to be the most important obstacle at present. The Chhattisgarhi bullock is the smallest and weakest in the Provinces, rarely more than 36″ high behind the hump and always in very bad condition in July, when the heavy work of transplantation has to be got through. Buffaloes are used for all heavy work and with the *datari* used now, are indispensible to prepare the fields for trans-

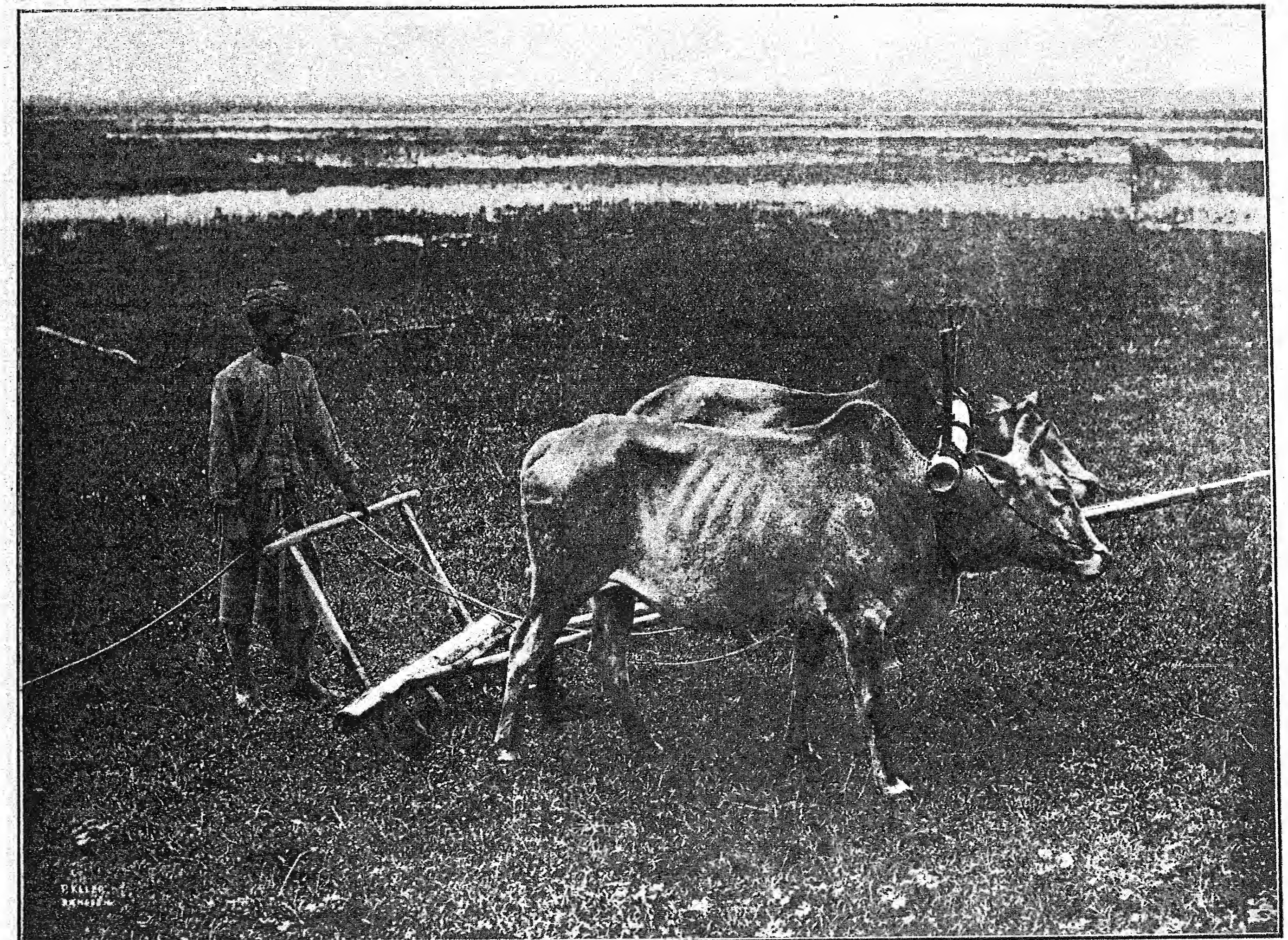
plantation. It may be possible for the little bullocks to pull the small *dataris* which will be tried next year : but for really thorough cultivation, I think, buffaloes will be required. There is now one pair of buffaloes for every 28 acres of rice land in Raipur District, including the zamindaris ; but the proportion of buffaloes to rice is much smaller than this in the open parts of the Khalsa. It is found impossible to breed useful buffaloes in the open country, owing to the absence of good grazing areas and the great heat of the shadeless plains ; consequently all the buffaloes in the open country are imported. By far the greater number come from Rewah and Saugor, and are bought at from Rs. 60 to Rs. 80 a pair. A few are brought from the zamindaris of Kauria and Bindra Nawagarh. In these remote places there is little demand for *ghi*, and the calves get most of the milk, so that they are fine strong animals and sell for double the price fetched by those from the north. They are consequently less used. Transplantation, while increasing the demand for buffaloes, will provide the cultivator with the means for purchasing them, and we may hope that in a short time the effective demand may so far increase as to make it worth the while of the inhabitants of the northern Feudatories to follow the example of their neighbours in Rewah, and send cattle to the 'Khaloti.' Meantime we must do what we can by hiring out buffaloes to needy cultivators, as suggested by the Deputy Director of Agriculture, by taccavi loans and possibly by co-operative credit to make smooth the rough path of progress under the feet of the conservative Chattisgarhi till he begins to cry 'Excelsior' without prompting.

This note may fittingly end with the statement that if a normal crop is reaped this year, the additional profits put into the pockets of cultivators by the labours of Mr. Clouston, Mr. Tundilall Powar and their assistants, will considerably exceed the whole of the annual expenditure on their salaries and the cost of the experimental farm at Labandih."

Transplanting should in future extend very rapidly in Chhattisgarh, if the Agricultural Department continues to work on the present lines. Of the enormous gain which its introduction will

mean to the farming community of this division, it is impossible to form anything like an adequate estimate. It should be possible within the next twenty years to raise the standard of cultivation to that already attained in Balaghat. For Chhattisgarh that would mean 1,926,450 acres of transplanted rice or an increase of 1,897,892 acres, which would increase the profits of the farming community of this division by nearly four crores of rupees annually.

PLATE XLVIII.



A. J. I.

BURMESE HARROW (HTUN).

RICE CULTIVATION IN LOWER BURMA.

By A. McKERRAL, M.A., B.SC.,

Deputy Director of Agriculture, Burma.

THE cultivation of rice in Burma has for long been the most important item in the agriculture of that country. Admirably adapted both as regards soil and climate for the production of this cereal, Burma is to-day the main rice-growing province of the East. For the year ending 1906-7 the exports of cargo rice from Rangoon amounted to about $2\frac{1}{4}$ million tons, most of it being shipped to the Straits, Japan, India, and Europe.

The area under paddy, is, moreover, rapidly increasing. Last year showed a total increase of some 9,000 acres, while the increase for the last five years, due to the boom in the rice trade and the competition among the various rice firms of the country, may be seen from the following table :—

For the year ending June.	Acreage under paddy in Burma.
1901	8,550,145
1902	8,257,154
1903	8,295,351
1904	9,306,531
1905	9,265,464
1906	9,281,407
1907	9,294.769

This shows an increase of nearly 9 per cent. in these six years. It may be of interest to readers of the *Journal* to know something of the conditions of soil, climate and cultivation under which this important crop is produced.

Agriculturally, Burma may be divided into 4 zones : (*a*) the wet zone of Upper Burma, (*b*) the dry or arid zone of Upper Burma, (*c*) a middle or central zone and (*d*) the Delta zone,

embracing the delta of the Irrawaddy River and also Amherst and Tavoy in the South.

In the dry zone and on parts of the central zone, paddy is either grown under irrigation or dry land varieties are sown, but in the Delta zone the natural rainfall is usually more than sufficient to produce good crops, and on this area the bulk of the rice crop of Burma is grown. It is with cultivation under the latter conditions that the present article is concerned.

The normal rainfall of the principal delta districts from 1st April to 30th November—the period during which the paddy crop is grown—is given in the following table.

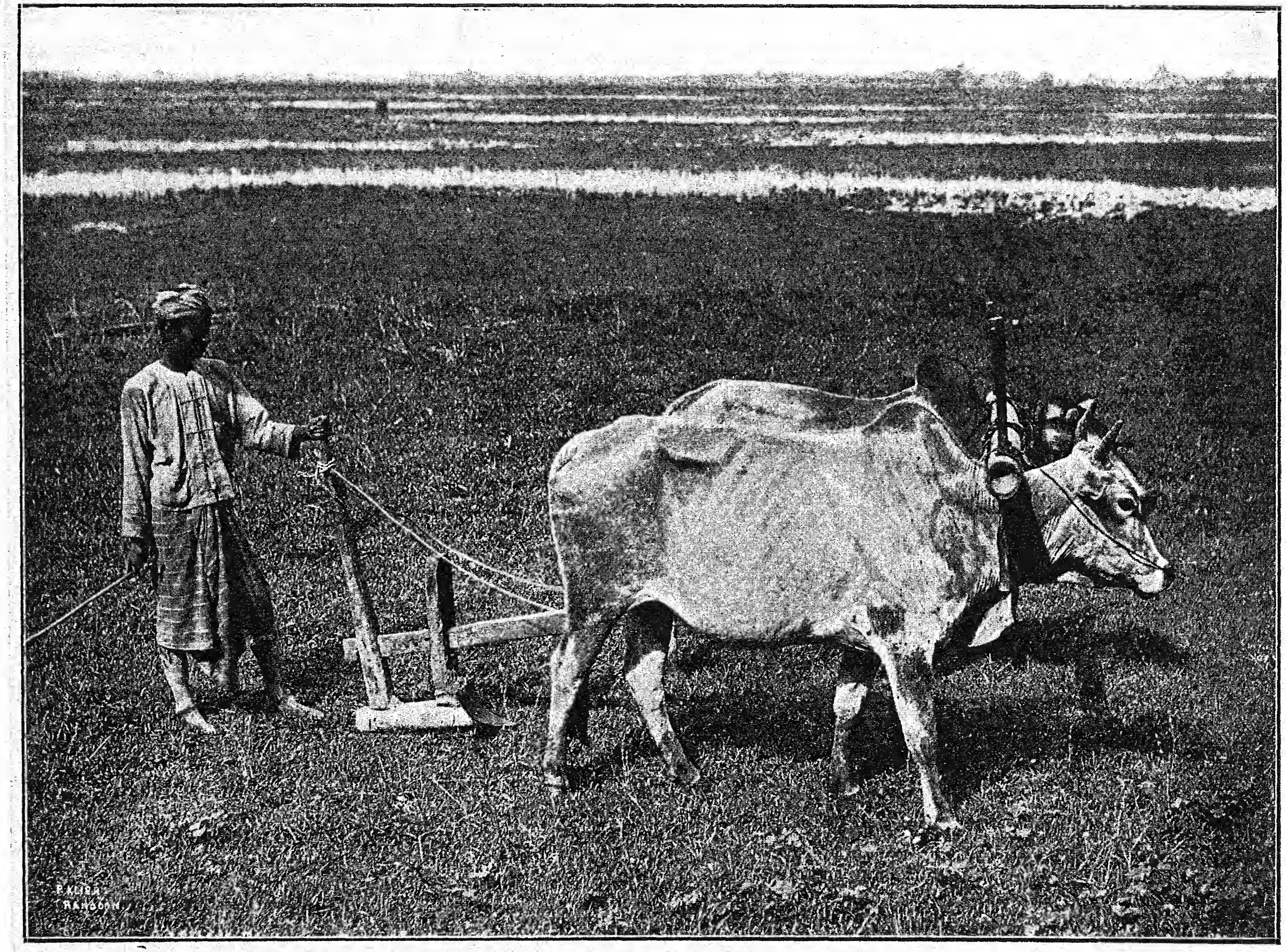
District.	Normal Rainfall in inches from 1st April to 30th November.
Akyab	197·90
Bassein	113·27
Wakema	95·58
Pyapon	91·35
Rangoon	97·03
Pegu	126·74
Nyaunglebin	127·28
Thaton	219·46
Amherst	204·93
Tavoy	211·04

It will be seen from the table that the demand of the semi-aquatic rice plant for moisture is amply met in all these districts.

The soils on which the cultivation takes place consists of what is geologically termed *recent alluvium*. Agriculturally they may be described as in general consisting of a stiff clay overlying a still stiffer clay subsoil. On drying in the hot weather they become generally very light in colour, crack readily, and assume a degree of hardness which practically precludes cultivation at that season of the year.

A remarkable fact in connection with the soils is the manner in which they appear to retain their fertility under successive crops of paddy and with little or no manure. Several sources of natural manurial supply, however, are evident; a considerable amount of grain is left annually on the soil due to "shaking" in the over-ripe ears; the stubble is left very long at reaping and is

PLATE XLIX.



A. J. I.

Burmese Plough (Hte).

Cultivation begins as soon as the first showers of the monsoon have softened the land sufficiently to admit of ploughing. This is usually about the last week of May or the first week of June.

In all good soils, when the rainfall is sufficient, early and abundant, transplanting is resorted to. But when the rain comes too late, or the cultivator is at a loss to obtain labour in time, the seed is simply broadcasted by hand. The Burman is perfectly aware of the superior merits of the transplanting system, which is practically universal in the Delta areas.

The first field cultivated is the nursery. This is most carefully chosen and is generally the best field possessed by the cultivator, being one in which an early and abundant supply of water is got. After the bunds have been carefully repaired, the nursery, if it contains sufficient water to render the soil soft, is ploughed with the *htûn* (Plate XLVIII). This is the Burmese harrow, and consists of a log of wood in which are inserted a varying number of wooden teeth. For paddy cultivation on the delta the one with six teeth is generally found most convenient. With this implement the soil is gone over six or eight times until it is of the consistency of fine soft mud, and on this mud the paddy seed is broadcasted at the rate of about one to one and a half baskets or more per acre.

The practice of sprouting seed before sowing is occasionally resorted to. The seed is soaked for a day and a night in water and is then placed outside the cultivator's house on a bamboo platform and covered with plantain leaves. Under these conditions the seed germinates, and growth in the field is expedited. But the practice is open to objection owing to the damage done to the young shoots in handling, and is only resorted to when the nursery is in a more or less unsatisfactory state owing to want of water.

Should the soil be originally too stiff to use the *tûn*, it gets a ploughing with the *Htè* or Burmese plough (Plate XLIX). This implement resembles more or less the usual type of primitive Eastern plough consisting essentially of a wooden sole with iron

PLATE L.

A. J. I.

Settun (used for cutting Grass on Paddy Land).

share, a handle, and a pole for attachment to the yoke of the bullocks. Its use is more common on the dry lands of Upper Burma than in the paddy cultivation of the Delta, where it is only used when absolutely necessary.

Both these implements—the *tûn* and the *Htè*—cultivate to a depth of only some 3 inches below the surface. It is often argued that the delta soils of Burma are so shallow that deep-working implements produce harmful effects, but the shallowness must be due in great measure to the continual shallow cultivation with these implements, resulting in the formation of a kind of "pan" at a depth of 4 inches or so below the surface. It should be remarked that manure, when it is used, is applied to the nursery only. It consists of either cow-dung or paddy husk, and these are applied in small quantities about a month before cultivation commences and subsequently ploughed in. The usual rate of application is about five or six cartloads per acre. The quantity of cattle manure available is limited, as Burmans do not keep milk cattle, but only as a rule a pair or two pairs of working bullocks or buffaloes, the manure produced by which is, as a general rule, badly collected and preserved.

While the young plants are growing in the nursery, the cultivator turns his attention to his other fields. By this time the monsoon has fairly set in, and this produces as a consequence a rank growth of grass on the fields which he has still to cultivate. To get down the grass Burmese cultivators use an implement called the *settûn* (Plate L). It consists of a round pole of hard tough wood about $2\frac{1}{2}$ inches in diameter. To this are affixed transversely a series of very sharp steel blades. The ends of the pole work in "bushes" in two wooden side pieces, and the blades, when the machine is dragged by the bullocks, revolve and cut down the grass.

The machine is in reality a simple form of lawn mower and is a very popular implement among paddy cultivators. Its use, we believe, dates back only some 25 years. The price is about Rs. 25.

When the grass has been got rid of by the *settûn*, the *tûn* is used to get the soil into suitable condition for the transplants.

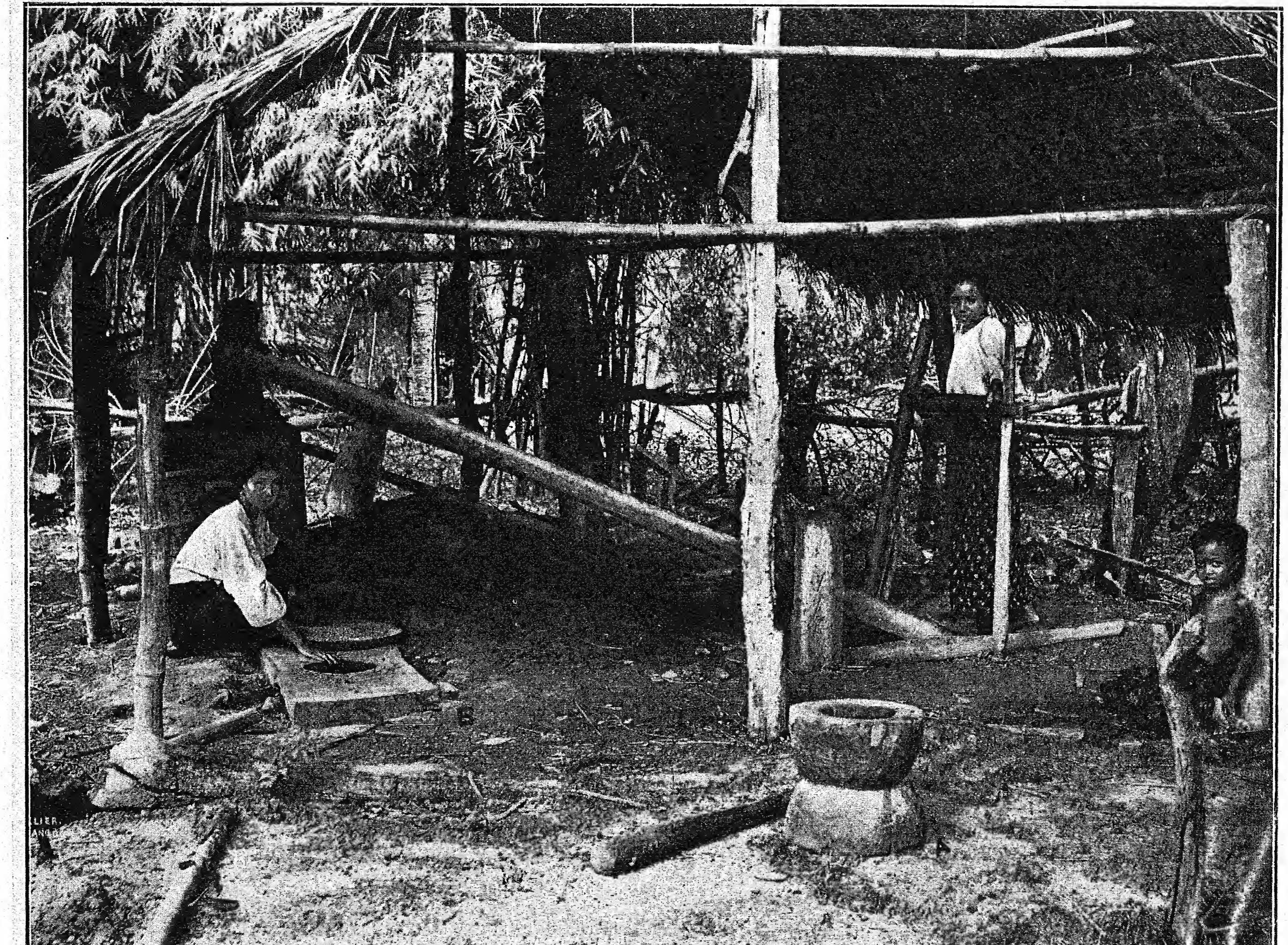
These are generally taken out of the nursery about a month after sowing, and are then about a foot or a foot and a half high. If the nursery soil is not good, however, it may be necessary to give them 40 days or so before they can be transplanted.

Transplanting, which is generally done by women, is performed as follows :—The plants in the nursery are pulled up and put in bundles of about 1,000 or more. These are carried to the fields and thrust into the ground in clumps of three or four together and at distances of about 6 or 8 inches apart. Transplanting is in some cases done by means of a bamboo stick which is used to thrust the transplants into the ground. The practice greatly expedites the work and at the same time relieves it of its drudgery, as continual stooping is rendered unnecessary. Recent experiments in Bengal seem to prove that one plant per hole gives as good results as four or five, and it will be interesting to discover whether the same holds under Burmese conditions. As a general rule, a paddy nursery in Lower Burma is reckoned to plant out from eight to ten times its own area. If one plant per hole gives as good results as three or four, it is evident that a considerable saving of seed might be effected.

In Upper Burma the work of transplanting is performed by women, who sometimes plant in time to the music of a Burmese band which is stationed on the edge of the field. The efficacy of this method is somewhat doubtful, as the care taken in transplanting and the speed at which it is accomplished are not always commensurate. The practice is an interesting survival of past customs and is quite commendable from the point of view of the workers. Transplanting paddy is laborious and dirty work, and the need of such a stimulus is perhaps excusable. The Lower Burman, however, has so far discarded the customs of his forefathers as to consider this aid to the work unnecessary.

From the time that the paddy is transplanted up to about a fortnight or three weeks before it is reaped, the fields are submerged under several inches of water. This water, however, must be got off just when the grain is ripening, otherwise the proper degree of hardness is not obtained. It is sometimes difficult

PLATE LI.



A. J. I.

Showing (A) Mortar and Pestle for husking paddy (worked by hand).
(B) ,, ,, ,, (worked by treadle).

to get rid of the surplus water in time, but as a general rule it can be run off into the marginal ditches, or it dries up by evaporation in time to leave the field perfectly dry at harvest time.

Harvesting takes place from the middle of November onwards, but December and January are the important harvest months. One very early glutinous variety known as *Kaukyin* is cut about the end of September or beginning of October.

Before harvesting and when the paddy is fully ready for reaping, men go through the fields and "fell" the standing crop flat to the ground with large bamboo poles. As all cutting is done by means of a sickle, this falling in one direction considerably facilitates the work of reaping. The cut crop is bound into sheaves which are left to dry on the field for a few days before being taken to the threshing floor. The sheaves are sometimes placed on the bunds, a precaution against a late shower of rain. When rain does fall, as it did last year, in December, considerable damage may be done to the cut crop. The bunds retain practically all that falls, and the grain, softened by the moisture and subsequently subjected to the sun of Lower Burma, sprouts and is rendered useless.

"Stooking" is occasionally resorted to, but is not a general practice.

The grain is threshed and winnowed in the usual way by bullocks and by hand. Threshing machines and winnowers are unknown, but it is possible that if their efficiency were once realized, many of the larger cultivators would adopt them.

A drawback to the use of these, as also to the manuring of the land, is that cultivators live generally in villages often at considerable distances from their holdings. Such a thing as actual living on the holding, is rare, and transport is often a serious item in the bill of costs.

With regard to the varieties of paddy used, nothing definite is as yet known. The Burmese claim to have about 120 varieties of Lower Burma paddies, but it is doubtful if these are all different types. Varieties are classified with respect to time taken in coming to maturity. Early ripening varieties are known as

Kaukyin paddies, medium ripening varieties as *Kauklat*, and the latest as *Kaukgyi* paddies. There is about ten days' difference or a fortnight's difference between each of the three kinds, so that *Kaukyin* varieties mature about a month sooner than *Kaukgyi*. The greatest demand at present by the large rice mills is for the varieties known as *Ngasein* and *Nga Chauk*, while other varieties find favour among the small native mills or for eating purposes by the Burmans themselves. (Plates LI & LII.)

Sales of grain take place at the threshing floors, where the brokers buy from the cultivators and re-sell to the large rice mills, or occasionally the large rice mills may send their own brokers. The price during recent years has been high. Last year as much as Rs. 165 for 100 baskets (9 gallons capacity) having been given in Rangoon. The cultivator of course gets much less, as the broker's commission has to come out of this, and probably from Rs. 80 to Rs. 100 per 100 baskets is a fair average price for a cultivator to get. In selling paddy in the districts there is no weight standard, but in Rangoon a standard of 46 pounds to the 9 gallons basket has been adopted, so that sales there are virtually by weight.

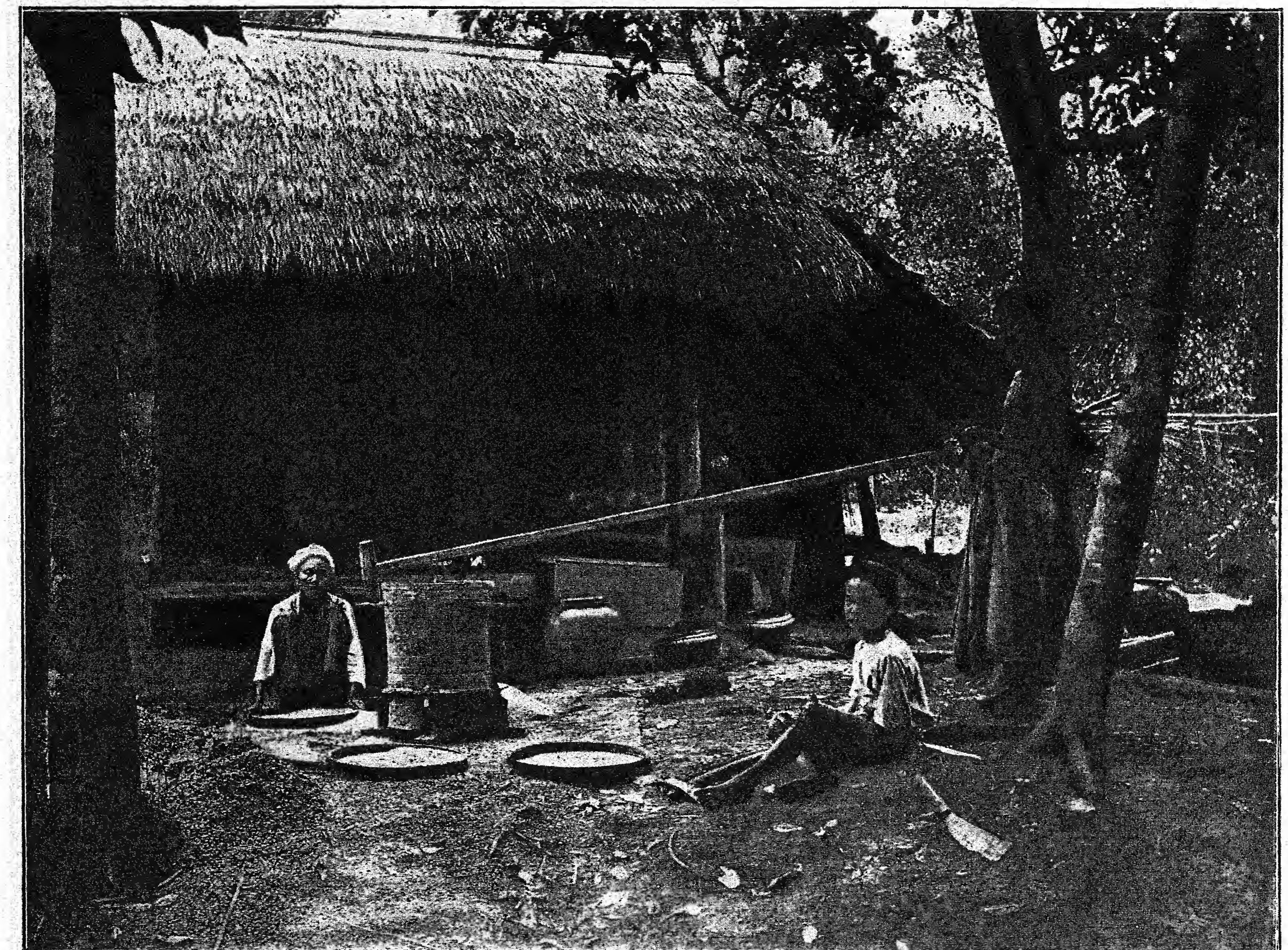
The cost of cultivation per acre is somewhat difficult to ascertain as the cultivator has not, as a general rule, a good idea of what an acre is, and no reliable experimental records are available. The following profit and loss sheet, however, will convey an approximate idea of profit per acre :—

Cost of ploughing, sowing and seed	Rs. 4-8-0
,, transplanting	,, 5-0-0
,, reaping	,, 5-8-0
,, rent	,, 6-0-0
Total expenses	Rs. 21-0-0

If the land yields 40 baskets, and this is sold @ Re. 1 per basket, the net profit per acre is Rs. 19.

As the yield, however, varies very much, as also the price from year to year, the net profit is somewhat uncertain, but on a wide average Rs. 20 to 25 may be taken as fairly representative.

PLATE LII.



A. J. I. BURMESE PADDY-HUSKING MILL.

Holdings vary much in size and may either be the property of the cultivator or rented by him. A common sized holding runs from 15 up to 30 acres, but in some parts of the delta we get holdings of two and three hundred acres in extent.

Well-to-do holders do not themselves work on the land and invariably employ hired labour. Natives of India and emigrants from Upper Burma supply what is required in that respect. Migration from Upper to Lower Burma is greatest at the reaping times, the certainty of the paddy crop in the delta thus forming a kind of guarantee against want to Upper Burmans whose crops are very often at the mercy of an insufficient rainfall.

A striking fact in the economy of Lower Burma is the amount of indebtedness among paddy cultivators. Although the rice crop rarely fails, except under conditions of flooding or late and careless cultivation, still much of the paddy land is mortgaged to the money lenders. A believer in the maxim of *carpe diem*, the Lower Burman freely spends his paddy profits in *pwes* (musical festivals), in building pagodas, and in various religious offerings. As a result the *chetty* is abroad in the land.

To sum up, it may be said that on the whole cultivation in Lower Burma is careful and good, according to the lights of the people. Its weak points are want of care in conserving and applying manure. also the absence of good methods of cleaning, grading, and selecting seed with a view to improve the type. The latter defect is, however, common to all Eastern agriculture which does not, as is the case in Europe, possess the advantage of having professional seed experts who make it their business to put on the market only the best samples.

THE CULTIVATION OF TAPIOCA IN TRAVANCORE.

By T. PONNAMBALAM PILLAY,

Excise Commissioner of Travancore.

The manihot, Cassava, or tapioca plant *(Manihot utilissima)* belongs to the *Euphorbia* tribe, and is closely related to the ceara rubber *(Manihot glaziovii)* so well known to every planter. It is now very commonly grown in Travancore, being the source of the tapioca meal, which constitutes an important article of food of the people of that State.

It is not indigenous to India, but appears to have been introduced from the tropical parts of South America. In Travancore, its introduction was due to H. H. the late Maharaja, who took great interest in the welfare of his subjects. By the introduction of this food plant, the large population of Travancore has been to a large extent placed beyond the reach of the famine conditions which prevail in other parts of India

There are about 15 varieties of the plant cultivated in Travancore. There is, however, a general similarity between them. The vigour of growth depends chiefly upon the fertility of the soil. The leaves are generally digitate, except in one case, when they are digitate partite, resembling *ganja* (*Cannabis sativa).* Chiefly for this reason, this variety is known as Ganja Tapioca. The tubers of this variety mature in six months. The period required for other kinds usually ranges from eight to twelve months.

The two main varieties are one sweet and one bitter. The latter contains a poisonous element, which can be got rid of by roasting or boiling, the water being poured away two or three times in the latter case.

Tapioca will grow in almost any kind of soil provided the climatic conditions are not too rigid. I have known it flourish up to an altitude of 2,000 feet. In fact, I believe, that it thrives better in Travancore on ordinary or inferior soil, with a little manure than on superior red land, where it needs constant watering. It is liable, however, to greatly exhaust the soil and render it unfit for cultivating the same or other crops unless heavily manured.

After selecting the land, it should be well ploughed. The soil selected in Travancore is usually of a porous character, where water cannot stagnate. The next process is the formation of ridges, three feet apart. Probably, however, pits $2' \times 2' \times 1'$ deep, three feet apart, are preferable. The pits should be filled with dried leaves, which should be burnt, as a precaution against white ants, and as a small instalment of manure. Ashes and other manures should be mixed with the soil. Ashes are, however, pre-eminently fitted to develop the tubers and ward off their insect enemies, which are numerous.

When the pit system is adopted, the pits should be so filled up with loose soil as to raise the centre of each to a height of seven or eight inches above the ordinary soil level. The raised portion of each mound should have a diameter of about one foot. In an acre there will be about 4,500 maunds. In the case of ridges, the planting should be at a distance of three feet.

Tapioca is propagated by means of cuttings from its stem, each cutting having at least three nodes. When the tubers are gathered, the stems are preserved for cuttings. These cuttings are planted in a slightly slanting position. Care should be taken not to plant them too deeply in the ground. Not more than three nodes should be underground. The cuttings should be put in when the ground is damp, or when rain is drizzling. There is no fixed time for planting in Travancore. The crop is cultivated throughout the year, with the exception of the dry months, December to February. In a week or ten days after planting, the cuttings begin to sprout, and the healthy sprigs can be distinguished from the unhealthy. Unnecessary sprigs should be removed. The soil should be slightly stirred and weeds removed occasionally.

In order to decide the time of harvest, the tubers of a few plants should be examined. If they appear to be mature, the crop should be dug up. After the tubers are gathered, the stems should be tied in small bundles and placed on the ground with the root end below, so that the capacity for germination may be retained.

The tubers will not keep long in their raw state. Within a week at most, they should be either sun-dried or boiled. If required for immediate consumption they are usually boiled, either alone or with tamarind leaves, the water being poured off two or three times. The tuber is also frequently reduced to powder, washed in clean water half a dozen times, pressed in a cloth and then dried in the sun, after which the flour will keep for a considerable period.

When required for storage or export, it is usually cut into slices and sun-dried after the thick outer skin has been removed. It is sometimes also boiled before being cut and sun-dried.

The cost of cultivation per acre and value of yield will doubtless be of interest. I am here speaking of cultivation under ordinary circumstances. My estimate for preparing the land, manuring, planting the sets, weeding, interculture and harvesting is Rs. 130 per acre.

The value of the crop.—Each plant may yield on an average 24 lbs. of tubers. Presuming that 4,000 are established per acre, the gross outturn might be 96,000 lbs. per acre, the value of which would be very considerable. At present, there has been a considerable fall in the price of Tapioca in Travancore, but after making ample allowance for this, and after allowing for interest on capital laid out to acquire the land, there is no doubt that a large profit can be secured.

It seems a great pity that advantage was not taken of the large stores of Tapioca in Travancore for the needs of the famine-stricken in North India. I understand that something has been done recently in introducing Tapioca from Travancore in the famine districts of Northern India, by the Salvation Army. There is also a small trade in Tapioca flour with Great Britain.

NOTES.

The following Memorandum has been issued by Professor Robert Wallace, Professor of Agriculture and Rural Economy, Edinburgh University.—Memorandum dealing with a Scheme for the Establishment of an *International Institute of Research.*

1. The fundamental object of the proposed organisation is primarily to develop the resources of the Commonwealths of Greater Britain and America, but ultimately to extend to all countries and benefit all sections of the human race by the conservation of the world's natural resources.

2. The fundamental means to be employed to be that of *physical research* in the widest sense, in contradistinction to *library research*, such as will mainly engage the attention of the International Institute of Agriculture at Rome.

3. The subjects to be taken up to be unrestricted as to classification, but to involve objects of international interest and importance, subjects which could not—on account of their magnitude, and, it might be in some cases, on account of the geographical distribution of the material to be investigated—be, in certain of their phases, so fully and comprehensively treated by one nation as by the combined efforts of two or more working together.

4. Although enlisting the sympathy and moral support of the respective governmental authorities, the work to be exclusively scientific and practical, free from all political questions and considerations, and to be conducted by highly trained experts, working under the general direction of a Board of Controllers, composed of the most prominent scientific men of the combined countries, to be chosen periodically.

5. The work not to interfere with that being done by the respective Government Departments of the included countries and their colonies and dependencies, and by institutions established for specific purposes, such as the Carnegie Institution of Washington; the International Fisheries Congress; the International Meteorological Committee; the International Association of Forest Experiment Stations; the International Congress for the Repression of Frauds in Foods and Drugs, and other similar bodies. But powers to be assumed to act in concert with, or through any of these or other bodies when it is deemed advantageous to do so.

6. The following intentionally restricted list of subjects will indicate a few of the directions in which research of an international kind could be instituted when, in the opinion of the controlling body of international representatives, the time is ripe for taking them up :—

(*a*) Sea fisheries generally, but especially in relation to the study of pelagic species ranging widely over the ocean, which can only be undertaken by an international body having free access to every necessary centre of investigation dominated by the associated countries.

(*b*) Atmospheric researches on a more comprehensive basis than that of existing Weather Bureaux—in the interests of commerce and of agriculture, including the great branches of the live stock industry.

(*c*) Researches bearing upon international quarantine of human beings and of the lower animals, and directed against plant diseases and insect pests, inclusive of their parasitic enemies.

(*d*) International food and drugs' distribution.

(*e*) The means of preventing the enormous waste in the utilisation of forest products.

(*f*) The future possible sources of motive power to do the world's work when the present sources of power

become exhausted or too expensive, namely, conservation of sun energy, and the utilisation of wind, wave, and tide power.

7. The widest possible basis has been suggested for the functions of this International Institute of Research, because it is intended to be a permanent institution crowning and co-ordinating the work of other institutions by providing means to carry scientific research to a higher level and into a sphere of greater usefulness; consequently enlisting the practical sympathy and support of all classes of citizens.

8. The first controlling body should consist of ten distinguished scientists, which may be subsequently added to—one half nominated by representative authorities of each of the two initiating countries—each member, after preliminary adjustments, to hold office for five years. The Chairman or President should be an additional member, nominated each year by the country in which the meeting is held, and be one of the highest authorities on International Law.

9. The head office should have a central home in London and in Washington, under the direction of a permanent Executive Secretary and an Assistant Secretary.

10. The work, according to its nature, to be carried on wherever the Institute shall determine, and in the manner which it shall appoint.

11. Suggestions as to subjects to be taken up to be invited from all publicly constituted scientific and other bodies, accompanied by a detailed statement of the objects in view, with all other necessary information.*

12. Besides Central and Local Meetings of Committees, there should be at least one annual peripatetic meeting, at which all the members of the supreme body should be present, held at

* Regulations limiting proposals to purely international objects, and necessitating their full consideration and support by groups of public bodies, or societies devoted to common objects, before being submitted; would be necessary to keep the number of propositions within workable bounds.

some convenient place to be selected, at least once a year in advance, in the associated countries.

*
* *

IMPROVEMENT OF SERICULTURE IN BENGAL.—The following short note will show to those who are interested in the silk industry what the Bengal Silk Committee has done to stamp out the chief disease of the silk-worm. Pebrine, as this disease is known, has been the ruin of many poor *raiyats*, and the consequence has been that the cultivation of mulberry and the rearing of silk-worms have been reduced in many places.

The first thing that is done is to select the seed-cocoons carefully. And in this selection, the two following points are considered :—

(*a*) The two ends of the cocoons are hard.
(*b*) The lesser the quantity of floss silk of a cocoon, the harder and better it is.

The moths of each crop are examined minutely after five days of their cutting out, and laying of the eggs, to see if they are free from disease. The worms from this seed are reared thinly in a mud hut where the temperature is regulated. This work is being carried on at the Central Baboolbona nursery. Successive careful selections of seed-cocoons since the erection of this nursery have made it possible to stamp out pebrine almost entirely. At present the Nistri seed is less than 1 per cent. pebrinized, and the Deshi which is naturally weaker and more liable to disease, is almost 1 per cent. pebrinized, whereas when the Bengal Silk Committee began the work some three years ago, the Nistri worms showed 50 per cent. pebrine and the Deshi worms almost cent. per cent. pebrine.

Seed (eggs) is distributed after the examination of the moths from the Baboolbona nursery to all the village nurseries from where pure or sound seed-cocoons are sold to the *raiyats*.

The Bengal Silk Committee's nurseries pay their own costs. If the zemindars of all the silk-worm rearing districts in Bengal

would help the *raiyats* by starting at least one nursery on the model of the Silk Committee's nurseries, they would themselves be benefited. For with the improvement in the silk industry there would be an increase of mulberry cultivation, and for mulberry lands the rent obtained is generally four to six times higher than that obtained for lands cultivated otherwise. The opening of improved nurseries would also result in the re-establishment of reeling factories, which have been closed on account of the deterioration of seed-cocoons, and thus occupation would be found for many who, since the closing of these factories, have either been reduced to beggary or have found their way to prison.

It is a matter of great encouragement that the Maharaja of Cossimbazar in Murshidabad proposes to start a Central nursery with some subordinate nurseries, and to lay out mulberry plantations estimated at a cost of a lakh of rupees, and it is hoped that other zamindars will also follow the good example set by the Maharaja.—(A. K. GHOSH).

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THE SANGAMNER AGRICULTURAL SHOW.—A District Agricultural Show was held from the 27th to the 29th February 1908, at Sangamner, in Ahmednagar District of the Bombay Presidency. The Show consisted of four main parts, a Cattle Show, a comparative exhibition by cultivators, a small exhibition of selected seeds and implements by the Agricultural Department and a series of lectures and demonstrations. There was very healthy co-operation between the Committee of the Local Agricultural Association and the Superior Officers of the Agricultural Department. The judging committees were composed of leading Patéls (village headmen). The comparative exhibition of produce by cultivators showed great care in selection and arrangement. The subjects of lectures delivered by the District Officers as well as the Officers of the Agricultural Department were suggested by the Association Committee. This Show was very successful in point of reaching the cultivators. Of the visitors numbering about 2,000, ninety per cent. were cultivators.—(EDITOR).

LIFT IRRIGATION IN THE BOMBAY PRESIDENCY.—The Government of Bombay have decided to grant *Tagai* to persons desirous of erecting mechanical pumping installations on any river or stream in the Presidency, and to charge no royalty on the water for a period of 25 years. Facilities for training fitters to keep such installations in order, have been made available at the Victoria Jubilee Institute, Bombay, at the College of Science, Poona, and at the Methodist Episcopal Industrial Mission School, Nadiad. The services of a mechanic on Rs. 200, and a workman on Rs. 40 a month, have been placed at the disposal of the Provincial Director of Agriculture for the purpose of providing expert advice and assistance to agriculturists in connection with the use of mechanical pumps. The question of appointing a duly qualified Agricultural Engineer, to undertake work in connection with the investigation of waterlifting, of well-boring, and of the introduction and use of agricultural machinery, is still under the consideration of the Government.—(EDITOR).

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RINDERPEST IN BOMBAY.—The report on the outbreak of rinderpest in the Bombay Presidency for the year ending 31st December 1907, shows that the disease has affected every district in that Presidency. This year 55,763 animals were attacked, of which 26,002 died; whereas last year there were 35,286 attacks and 19,700 deaths. The only redeeming feature was a slight reduction in percentage of deaths to attacks during 1907. This was probably due to abatement of the virulence of the disease and the effects of inoculation. There was decreased mortality in all the districts where the cattle were inoculated. The inoculators having gained experience in their work, there were fewer deaths after inoculation than in previous years, the percentage of deaths among inoculated cattle being 1·41 as against 2·25 in the previous year.—(EDITOR).

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SHILLONG SHOW OF GARDEN AND FIELD PRODUCE.—The annual show of garden and field produce was this year held at Shillong, in the compound of the European School, on the 13th

and 14th May 1908. There was a large attendance of spectators on both days. Owing to the drought which had prevailed for some months before the show, neither vegetables nor flowers were as good as they usually are in the Khasi Hills in the middle of May, but there were good specimens of many vegetables, some fruits and dairy produce. There was a good show of poultry and eggs, and it is believed that measures for the improvement of the local breeds of fowls will be welcomed by the people.—(EDITOR).

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EGYPTIAN COTTON IN SIND.—In the last April issue of the *Agricultural Journal of India* (page 172), Mr. Henderson gave a short account of the trials of Egyptian cotton in Sind and of the results of Government auctions in facilitating the disposal of the cotton. The Bombay Government have since published a detailed report upon the working of the scheme of Government auctions at Mirpurkhas during 1907-08. The total number of maunds auctioned was 5,433 (against 4,879 in 1906-07), and the total sum realised was Rs. 62,754 (against 57,700 in 1906-07). Both Abassi and Metafifi varieties were put up for sale this year. There was very little demand in the beginning for the Metafifi. Abassi obtained a price varying from Rs. 11-12-0 to Rs. 14-2-6 per maund, and Metafifi from Rs. 11 to Rs. 11-12-3. The deductions made by Government for transport, etc., varied from Re. 1-6-6 to 7 annas per maund. The chief buyers were representatives of Ahmedabad and Bombay mills, and one or two exporting firms. It is also reported that samples were purchased for shipment to Japan.

It is estimated that under a fourth of the total outturn of the cotton was sent into the Government auctions; the rest was disposed of by the cultivators privately. The deductions made by Government from the prices realised may have deterred many cultivators from sending their cotton to the Government Depôt. The prices obtained by private sale were fairly adequate as they were largely regulated by those obtained at the Government auctions. However, cultivators who had a stock of cotton after

the last auction was over, could not dispose of it at a good price. As satisfactory results were obtained from auctions held in the last season, the Bombay Government has sanctioned the proposal to continue them for another year.—(EDITOR).

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DEGUMMING OF RHEA FIBRE.—Many enquiries have been made as to the new process said to have been invented in India for degumming Ramie fibre. As far as we are aware, no such process seems to have been invented in India, but some such discovery by Mr. W. McGregor Smith, of Shanghai, was reported in the *Indian Trade Journal* of 26th December 1907. A copy of an extract from this Journal is given below for the information of our readers.

"The great difficulty hitherto in connection with the use of Ramie for textile purposes has been the softening and degumming of the fibre, which has rendered it almost impossible to weave a pure Ramie warp. A process has recently been discovered by Mr. W. McGregor Smith, Shanghai, by means of which, it is reported, the Ramie fibre becomes a soft filasse superior to cotton yarn and very much like silk. The process lasts but ten minutes (says the *Shanghai Mercury* in its report of a demonstration by the inventor), and is most simple. The machine is first placed in a vessel containing boiling water, to which is added some composition, the recipe for which is kept secret, and after boiling four and one half minutes it is washed, bleached and thoroughly degummed. The fibre comes out almost snow-white and is very much like silk. The fibre is not in the least injured by the process, but rather strengthened."

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BOARD OF VETERINARY SCIENCE IN INDIA.—The Government of India, encouraged at the success of the Board of Agriculture in India, suggested that a Board of Veterinary Science be instituted on similar lines. Accordingly the first meeting of the Board of Veterinary Science in India was held at Calcutta on the 10th, 11th and 12th February 1908, under the presidency of the Inspector-General, Civil Veterinary Department. Fifteen members

and eight visitors attended the Board. The Agricultural Departments were sufficiently represented.

It was decided that the meeting of the Board should be held once at least in three years, and the Government of India should fix the time and place of meeting. It was observed that the present staff is not sufficient for the suppression of cattle diseases in India, and that it should be strengthened, especially the staff of the Imperial Bacteriological Laboratory. On the outbreak of more important diseases, it was agreed that the Bacteriological Department ought to indicate to Provincial Superintendents the points on which information was required. The Board recommended that an advanced course for a fourth year in English should be added to the curriculum of one or more of the existing Veterinary Colleges, for the training of Deputy Superintendents and Veterinary Inspectors. It was considered necessary to improve the facilities for educating Indians in Veterinary Science by the appointment of an additional Professor of Pathology in each College. The Board agreed that the manuscripts of articles or books on purely veterinary and technical matters by the Officers of the Department should, before publication, be sent for approval to the Inspector-General, Civil Veterinary Department. —(Editor).

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Well-boring in Chingleput District, Madras Presidency.—The well-boring operations in Chingleput have revealed very large supplies of subterranean water in the district. The number of borings put down from the commencement of operations up to the 31st December 1907, comes to 94 for new wells and 122 in old wells, of which 46 and 56 respectively proved successful. The *ryots* are sinking new wells and improving the supplies in the old ones with the assistance of Government loans, but the rate at which improvements are effected is slow. Mr. Chatterton attributes this to lack of energy, want of capital on the part of the *ryot* and to the local rules for State Loans. The Madras Government think of removing this last obstacle by amending the rules.—(Editor).

NOTE ON THE GROWING OF TOBACCO IN INDIA FOR THE EUROPEAN MARKET.—Out of a total area of 220,000,000 acres under crops in British India and Native States, over one million acres are under tobacco. This figure is probably well under the mark. No statistics are at hand to show the value of this crop, but if we take the figure of £5 or Rs. 75 per acre as representing the gross yield, we have a trade equal to over 5 million pounds sterling, which would bring it into the fifth or sixth position of importance among the crops of India.

The varieties, whatever their origin, are mostly of the native type and cannot be classed commercially with any of the well-known cigar and pipe tobaccos of other countries. Only the varieties grown in Coimbatore, and probably Rangpur, are at all fit for European consumption. The amount taken up by this trade is comparatively small and scarcely affects the total figures. If it were possible to introduce into India a better tobacco plant and improve the present methods of growing and curing so as to produce tobacco suited to the European demand, the value of the crop would be enhanced enormously and an export trade would be created which would in all probability rank of first importance. The climate and soil of many parts of India have proved themselves eminently adapted to the growth of the tobacco plant, and the writer has witnessed results which, from the agricultural aspect, left nothing to be desired. How is it, then, that the country has so far failed to produce a high-grade product? The reasons appear to be two. First, the plant commonly grown in India is a degenerated specimen, too coarse for the European market, and secondly, the curing methods adopted are too crude and primitive to make even a good leaf into good tobacco. The first defect is not difficult to remedy as will be explained below, for good quality varieties of exotic tobaccos can be grown in India with success. The second defect, that of curing, is really the one difficulty which, in the opinion of the writer, stands in the way of improvement. In foreign countries where this crop is grown with success, the climate is also suited to the curing. In India this is just the opposite. Though the crop will grow well,

the climate is such that the curing is extremely difficult. In the one case you have a warm, humid atmosphere giving the correct amount of heat and moisture night and day, so that the process is performed in the best manner under *natural* conditions. In India the natural conditions are, as a rule, positively hostile to good curing, for the climate is too dry, and the fermentative changes required do not take place. That being the case, the remedy seems to lie in the introduction of artificial means under which *optimum* conditions of combined heat and moisture can be supplied. If this were done, there can be little doubt that India would soon come into line with other tobacco-growing countries of the world.

The writer has experimented with many varieties of tobacco both at Pusa and Dalsing Sarai. Some 25 kinds of exotics were introduced. The majority had to be discarded as being entirely unsuited for growth in this climate. Some six varieties remained, of which one known as Zimmer's Spanish showed itself superior to all the others, and has been appreciated and retained by ordinary cultivators. It is well suited to the soil and climate of Behar and would probably do equally well in other parts of India. The yield obtained from this variety in 1901 at Dalsing Sarai was 1,840 lbs. of dried leaves per acre. When attempts were made to cure the crop, the difficulties enumerated above became apparent. The climate was so dry that it was found impossible to handle it once it had been housed, and the required fermentation consequently could not proceed. At that time artificial means of control were not available, and the experiment had to be abandoned. This year the same variety is being grown at Pusa where provision is being made to entirely control the drying and curing process by artificial means, the results of which will be awaited with interest.—(BERNARD COVENTRY).

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A COMPARATIVE TEST BETWEEN AN IRON AND WOODEN SUGARCANE MILL.—Through the courtesy of the late Mr. Minchin of the Aska Factory, a comparative test of the iron and wooden sugar mills used in the Ganjam district was held at Aska last

March with a view to ascertain the differences in the jaggery produced.

The mills were both, of the two-roller type worked by a pair of buffaloes. The iron mill was not a particularly efficient machine, as will be evident from the fact that the canes were put through twice; the same process was adopted with the wooden mill.

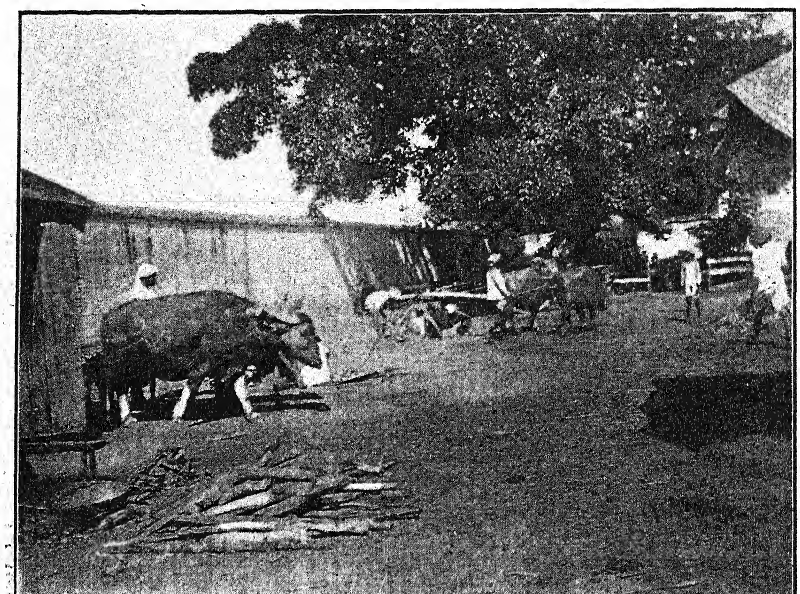

FIG. 8. Wooden Sugarcane Mill.

The two mills were erected side by side and work was started by first passing some canes through each mill to remove any accumulation of dirt that might have had an effect on the juice. The canes fed to each mill were picked at random from a single heap; the top few joints were cut off. Both mills worked simultaneously, and the boilings were carried out by an expert boiler under personal supervision. Four pot-fulls of juice were obtained from each mill, and the crushed canes were then put through again, the second lot of juice being added to the first, and the whole thoroughly mixed and strained before sampling. The jaggery was not boiled down in a pan, this not being the custom in this district, but the juice was kept boiling in a number

of pots, the last of which where evaporation is allowed to proceed furthest, being replenished from time to time. The juice is turned out while still just viscid into a small earthenware vessel and allowed to harden. A little oil is added to check the formation of froth. The density of the juices was roughly determined and was found to be as follows :—

Iron mill	first crushing	16
ditto	second „	15
Wooden mill	first „	14
ditto	second „	15

The juice from the wooden mill was visibly darker in colour and contained more floating impurities. It was slightly more acid to litmus paper.

The juice was boiled on the 1st March. The jaggeries were not examined until the 15th April. There were four samples, two from each mill, limed and unlimed respectively. They were analysed by the Madras Agricultural Chemist with the following results :—

	Iron Mill.		Wooden Mill.	
	Limed.	Unlimed.	Limed.	Unlimed.
Sucrose	88·10	80·00	90·60	79·20
Glucose	5·03	9·44	3·65	8·09
Moisture	3·22	6·52	2·52	7·42
Ash	1·32	1·78	1·20	·88
Total ...	97·67	97·74	97·97	97·19

There were very marked differences in the appearances of the samples which bear out the differences indicated by the above figures. The pots had to be packed up before they were properly hard; both the limed samples had, however, dried enough to enable them to keep their shape. The jaggery in the two unlimed pots had flowed from the bottom all round the sides; this difference in dryness was evident even when the pots were examined on the 15th April. That from the wooden mill was, however, very much stickier than the iron mill sample, though it actually contained less glucose. The iron mill sample had crystallised fairly well throughout and had drained well;

the wooden mill sample had, on the other hand, practically not drained at all. These differences may be due to differences in the degree of boiling.

The limed samples are both much better; both had freely crystallised, and both were well drained; the grain of the iron mill sugar was a little finer and a little darker in colour.

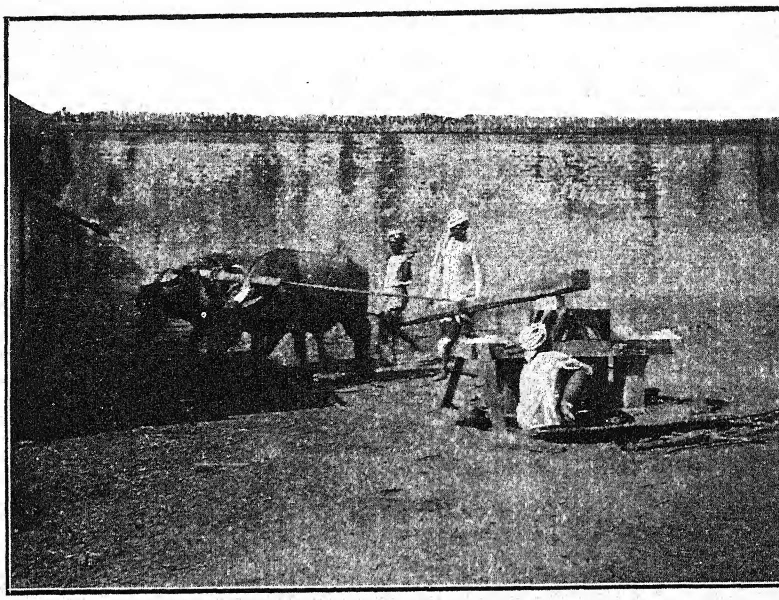

FIG. 9. Iron Sugarcane Mill.

A comparison of these facts shows that though the iron mill does its work so much more effectively, yet the quality of the jaggery made from the juice expressed by it is not so good. The extra crushing introduces impurities and gives a more acid juice, tending to produce a higher glucose content. The supposition that the small amount of lime added was not sufficient to neutralise the more acid juice, *i.e.*, that expressed from the iron mill, though it neutralised the wooden mill juice, will explain the relatively greater differences seen in the limed samples.

The colour of the jaggeries was in the order of their sucrose content. It was this question which really led to the test being made, as the Aska *ryot* objects to the iron mill on the ground that he gets a darker jaggery which the native refiners, who treat a great deal of the sugar produced in this district, do not like.

His objection is based on facts, but the quicker and more efficient work turned out by the iron mill will undoubtedly be found economical and should lead to its adoption.—(R. W. B. C. WOOD).

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OIL-ENGINE AND PUMP IN THE TELINKHERI GARDENS AT NAGPUR.—In May 1906, an oil-engine of 5 B.H.P., with a 2″ centrifugal pump was set up at a well 30 feet deep in the Telinkheri Gardens, Nagpur. During May and June, when the pump was worked, the depth to water from the soil surface was 14 feet. The engine was found to empty a depth of 9 feet of water in $3\frac{1}{2}$ hours. It was only possible to work the pump $3\frac{1}{2}$ hours in the morning and $2\frac{1}{2}$ hours in the afternoon, as the well was emptied in these times.

The cost of working this engine and pump per day was as follows :—

Engineer	... ...	Rs. 0	8
Coolie	... ...	„ 0	4
Kerosine	... ...	„ 2	14
Lubricating oil	... ...	„ 0	4
		Rs. 3	14

If the depreciation of the machinery is added to this at the rate of 10 per cent. on the initial outlay and interest at 4 per cent. on the same, the total cost comes to Rs. 4-8-7. 6,480 gallons were raised to a height of 19 feet per hour or 38,880 gallons per day of six hours. On an average, the number of gallons that was raised per anna is, therefore, 535 gallons. A *mote* worked by a pair of bullocks can raise 56 *motes* or $56 \times 30 = 1{,}680$ gallons per hour from the same well, when worked continuously. One pair of bullocks can do steady work for six or more hours a day and can therefore, at the least, raise 10,080 gallons per day. The approximate cost in this case will be as shown below :—

Food for bullocks	... ...	As. 8
Wages of a coolie	... ...	„ 4
Depreciation and interest on capital outlay	... ...	„ 2
		As. 14

The cost of lifting water by a *mote* from this particular well is, therefore, 720 gallons per anna, or 185 gallons more than can be raised by the oil-engine per anna.

Although reduction can be made in the cost of pumping by the substitution of the cheaper oil known as liquid fuel for kerosine, still it should be stated that oil-engines can only be economically used where the supply of water is sufficient to keep them working for ten hours a day.—(EDITOR).

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FLAX IN BEHAR.—Mr. Vanderkerkhove, the Belgian Flax Expert, took home some flax straw of fine quality, grown at the Dooriah Factory, with the object of retting it in the River Lys. The result of his experiment was most satisfactory. The dry straw yielded 22 per cent. of fibre and 5 to 6 per cent. of tow. These outturns compare well with the highest returns of Belgium flax.—(EDITOR).

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THE APPLICATION OF THE METHODS OF DRY-FARMING TO THE AGRICULTURE OF SEMI-ARID TRACTS IN INDIA.—Methods of dry-farming have made the successful cultivation of crops possible in the semi-arid tracts of the United States of America in places where the annual rainfall is not more than 12 inches. The system depends for its success on thorough tillage which helps to retain the rainfall as it falls on the land.

In the semi-arid Districts, the loss of moisture from bare fields after the harvesting of crops is believed to be greater than at any other time. If the land is ploughed during dry hot weather and is allowed to remain loose as left by the plough, there will be a great loss of moisture. Deep ploughing is desirable, but to avoid loss of moisture at any season it is advisable to produce a finely pulverised surface by harrowing or otherwise, and thereby also somewhat consolidate the soil beneath. The upper layer should be kept continuously friable by tillage. By deep ploughing, the soil can store the rain that falls. If a crust is allowed to form on the surface, evaporation from the soil will be greatly increased.

It is advisable to sow seed evenly by drilling it and to pack the soil around the seed.

In India, after sowing, interculture with a bullock hoe is of great advantage, and especially after every fall of rain, as soon as the surface soil becomes fairly dry and usually until the crop gets a foot high.

There are some varieties of cereals and of other crops that are particularly drought-resisting, and their cultivation lends itself to dry-farming.

It is well known in India that 12 inches of rainfall, if well distributed, are sufficient to mature certain cereal crops, but we would like a heavier rainfall. Usually in Thar and Parkar on the border of the Sind desert, cultivation of ordinary dry crops is fairly successful. In the Deccan too, it has been found that this amount of rainfall in the *Kharif* or *Rabi* season is fairly sufficient for some cereals.

With a view to test the efficacy of the system of dry-farming in the semi-arid tracts of the Bombay Presidency, the Agricultural Department has obtained the seed of 22 drought-resisting varieties of cereals and other crops and arranged for special cultivation. Twenty-five acres of land have been acquired in the Ahmednagar District for experiments which are chiefly as follows :—

I. Increasing the capacity of soil to store water by—
   (*a*) deeper and more thorough preparatory tillage ;
   (*b*) firming the under soil by a sub-soil packer and roller.

II. Preventing evaporation by inter-tillage.

III. By spacing the number of plants per acre.

IV. Assisting germination by—
   (*a*) moistening seed ;
   (*b*) firming after planting.

V. Increasing the amount of stored water by impounding it within embankments.—(EDITOR).

FOURTH CATTLE SHOW AT ONGOLE.—The Show opened on the 14th March 1908 and extended over two days and was a good one. It was managed by the local Agricultural Association with Government help. The Ongole cattle breed is one of the few best in India. Some bulls of this breed were last year exported to South America, and this trade should be encouraged. It must bring the breed into favour and raise prices. The best bull exhibited was sold for Rs. 350.

In order that the breed may be maintained at a high standard, Government purchased six of the best bulls and sent them to the Guntur District.

The chief other features of the Show were (*a*) the delivery of lectures on cattle-breeding and Agricultural subjects ; (*b*) the exhibition of Agricultural and Forest products ; and (*c*) the exhibition of fibre extracted from indigenous plants.—(EDITOR).

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THE TOLERANCE OF PLANTS FOR SALTS IN ALKALI SOILS.—Kearney and Harter of the United States Department of Agriculture in the Bureau of Plant Industry publish some very interesting results (Bulletin No. 113) on the tolerance of plants for salts in alkali soils. They clearly show that different genera and species of plant differ greatly in their power of resistance to alkali salts ; also marked differences in resistance are shown between individual plants of the same species. Thus, there seems a possibility of selecting strains of plants fairly resistant to alkali salts. The results may therefore be of interest to those who have to deal with alkali soils in India.

They conclude their paper with the following summary :—

(1) Different varieties of the same species, *e.g.*, of wheat, sorghum, and oats, differ considerably in their powers of resistance to the action of magnesium and sodium salts in pure solutions.

(2) Closely related species of the same genus, *e.g.*, Egyptian and Upland cottons show similar differences.

(3) Great differences exist between different plant species, even when belonging to the same family, in tolerance of pure

salt solutions not only as regards the absolute toxicity of each salt, but also as regards the relative order of toxicity of the salts. Of the 8 species used in these experiments, maize is on the whole the most resistant of pure solutions, and cotton the least.

(4) Seedlings grown from fresh seeds are much more resistant than those developed from older seed.

(5) The presence of calcium in excess greatly diminishes the toxicity of the magnesium and sodium salts to all the plants tested, the neutralising effect being greatest in the case of sulphate of magnesium and least in that of sodium carbonate.

(6) The addition of calcium sulphate tends to equalise the toxicity of the different magnesium and sodium salts.

(7) As a rule, the more sensitive the species to the pure solution, the greater is the counteracting effect of the calcium salt; hence the presence of the latter tends to diminish the differences in the resistance shown by different plant species in the presence of pure solutions.

(8) Amounts of calcium sulphate smaller than that necessary to saturate the mixed solution also show a marked neutralising effect upon the more toxic salts, but the minimum amount of calcium sulphate capable of producing such effect remains to be determined.

(9) For the white lupine the presence of 0·5 grain of calcium sulphate is as effective as seven times that amount in neutralising sodium chloride, while for sorghum 0·1 grain is as effective as twenty times that amount.

(10) To secure the most effective possible neutralization of sodium chloride, five times as much calcium sulphate is required in the case of the white lupine as in that of sorghum, although the limits for these two plants are approximately the same both in pure sodium chloride and in sodium chloride plus an excess of calcium sulphate.

(11) While the comparative resistance of the different plants to pure solutions of the single salts can in no way be correlated with that of the same species to the different combinations of "alkali" salts occurring in Western soils, their

behaviour in mixed solutions shows a much closer approach to that observed under natural conditions.—(H. E. Annett).

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Rat Poison.—The Punjab Medical Department have tested a poison for rats. It is said to be efficient. The poison is supplied by the Inspector-General of Civil Hospitals, Punjab, Lahore, at 12 annas a tin. A tin contains about nine ounces of the stuff, sufficient for about sixteen hundred baits. Each bait is fatal to a rat in less than 48 hours. The contents of one tin should be added to one seer of *gur* (crude sugar) and thoroughly mixed, sufficient *ata* (wheat flour) being added to make a stiff paste. This mass is then divided into 1,600 large pills. Detailed information regarding the composition, manufacture and use of the poison can be obtained from the Inspector-General of Civil Hospitals, Punjab, Lahore.—(Editor).

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Report of the Patna Divisional Agricultural Association, 1907-08.—The report covers the period from the beginning of July 1907 to the end of June 1908. This Association has an annual Industrial and Agricultural Exhibition. One member, who undertook the experimental cultivation of jute in South Behar, has succeeded in producing fibre of good quality. Encouraged by this success, the Association has distributed some jute seed. The Association also endeavoured to introduce a fine variety of *Aus* paddy. The cultivation of Dharwar American Cotton with an outturn of 6 maunds per acre is referred to. Another successful introduction into the Patna Division is of *Sialu* (winter) Jowar of the Bombay Presidency. Note is also taken of the trials made with foreign implements The Rajeshwar Plough and Albion Reaper were found to be suitable. The Association obtains from the Civil Veterinary Department, Bengal, advice in veterinary matters. The distribution of good seed of ordinary crops is making progress. It is proposed to modify the system of membership of the Association and to enroll intelligent cultivators as members. The Association

invited 50 cultivators of the Patna District to the last Industrial and Agricultural Exhibition at Bankipur where lectures on agricultural subjects were given.—(EDITOR).

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THE FOOD OF THE PEOPLE IN TIMES OF SCARCITY, UPPER BURMA.—Rain is scarce and capricious in the dry zone of Upper Burma, and averages about 27 inches a year, falling as low as 12 or 15 inches in many places and seldom rising above 35 or 40 inches. The immediate consequences are drought and scarcity of food and water. The mainstay of the population in the affected districts is, generally, their cattle which in bad seasons they take down to Lower Burma, and sell, buying rice and other necessaries with the money realized. But, besides the resources afforded by the sale of cattle, the population find other means of subsistence in various yams, tubers, roots and nuts which are dug up or gathered in the jungles.

Of tubers, the most common are the bulbs of the *Dioscorea dæmona*, known in Burmese as "Kywe-u," and of the *Dioscorea alata*, called "Myauk-u". Fortunately, these are common all over the dry zone. It is a general belief among Burmese jungle folk that these sprout up only in bad seasons. The truth is, of course, that at other times these wild tubers are not sought for. The tubers are first cut up in slices and soaked for some time in two or three changes of cold water, and then boiled in the ordinary way.

Another wild tuber, the bulb of the "Samidauk," the *Gloriosa superba*, is sometimes eaten. But a soaking in several changes of water for twelve consecutive hours, at least, is necessary to remove a poisonous principle, the tubers having been previously cut up in thin slices.

Amongst other food stuffs consumed in times of scarcity, when rice and other staples are scarce, we must note the roots of the toddy-tree, the "Htan-bin" (*Borassus flabellifer*), of the cocoanut tree, "On-bin" (*Cocos nucifera*), and of the "Pebin" (*Corypha umbraculifera*), also the tender new shoots called "Hmyit" of the common Upper Burma bamboo tree (*Dendro-*

calamus strictus) which sprout in May and June after the first showers of rain.

Another article of food, little known at present, is the Burmese "Lunzan," the nut kernel of the "Lunbin" or *Buchanania glabra*, a forest tree which grows wild throughout the dry zone of Upper Burma and is common in the districts of Pakokku, Minbu, Magwe and Myingyan. It is eaten in the raw state or after being roasted or fried. Lunzan can be obtained at Pakokku, Yenangyat, Seikpyu and in the Yaw Valley, in the Pakokku District, at Zibyubin and Sinbyugyun in the Minbu District, at Yenangyaung and Magwe District, and probably throughout the dry zone of Upper Burma. It might in time become a valuable article of trade.—(LEON AUBERT).

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BEES IN COORG.—There are two kinds of honey bees in Coorg, the large and the small. The former are not domesticated. Their nests are found on high trees, preferably *Lagerstrœmia microcarpa*, and the wild mango tree, under the arches of bridges and public buildings and precipitous rocks. There is a hill in Coorg called Jain Kal Betta (Honey rock hill) where these bees have been settled from time immemorial. Their honey has an acid taste and is not much valued, but the wax is much sought after. It is a very difficult task to get at the hives, owing to the inaccessible position in which they are found. In Coorg, the Jain Kurubas, a jungle tribe, are adepts at taking the honey.

The small bees are domesticated not by the Kurubas, but by ordinary ryots. A large earthen pot is smeared inside with bees' wax scented by rubbing the leaves of the wild cinnamon tree on the wax. About a dozen small holes, $\frac{1}{2}''$ in diameter, are bored into the pot, and bees' wax scented by the wild cinnamon leaves is rubbed round the holes on the outside. The mouth of the pot is closed by tying a cloth over it, and it is then placed upside down in the jungle, in a shady place. In time the pot will usually be found to be inhabited by bees. The pot is then very cautiously removed at night and placed in a dry place,

free from ants, facing the east under shades. Some people have a hundred or more pots in their farm-yard. The bees are not disturbed by the people of the household. No attention whatsoever is paid to them till about June when the honey is removed. As a rule, all the honey is taken, but some careful bee-keepers leave at least one comb in each pot. Some pots contain about a dozen combs, yielding about three seers of honey. The price of a seer is from four to six annas according to the season.—(G. HALLER).

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PEAS AND BEANS GROWN IN BURMA.—There are about 26 varieties of peas and beans grown in Burma. The chief of these are the following:—*Crotolaria juncia*, Sann-hemp; *Cyamopsis psoralioides* and *Arachis hypogæa*, Pea nut; *Cicer arietinum*, Chicken pea or gram; *Lathyrus sativus* and *Pisum sativum* and *arvense*, Peas; *Glycine hispida*, Soy beans; *Canavalia ensiformis*, Sword bean; *Phaseolus mungo*, Mash-kalai; *Phaseolus radiatus*, Mung; *Phaseolus lunatus*, Lima bean; *Phaseolus calcaratus*, *Phaseolus ricciardianus*, *Phaseolus aconotifolius* and *Phaseolus vulgaris*, Kidney bean; *Vigna catiang*, *Pachyrhizus angulatus*, *Dolichos lablab*, *Dolichos biflorus* and *Cajanus indicus*, Pigeon pea, etc.

Crotolaria juncia, Sann-hemp, is grown in Central Burma to a very large extent. The fibre is used for making fishing nets.

It is not necessary to refer particularly to the other pulses which have been referred to as they are all common food grain crops in India, and their value as such is commonly known.—(EDITOR).

REVIEWS.

A SHORT NOTE ON A MONOGRAPH BY MR. D. QUINLAN, M.R.C.V.S., SUPERINTENDENT, CIVIL VETERINARY DEPARTMENT, BENGAL, ON THE CATTLE AND AGRICULTURE OF THE DARJEELING DISTRICT.

THE conditions of agriculture in different parts are exceedingly varied and difficult. The cultivators classify the soils into three heads—white, red and black : of these, the black soil is the richest and is more suitable for dry crops such as maize and *marua*. There has recently been great extension of cultivation especially in the Kalimpong tract, owing to the influx of Nepalese and Bhutia settlers. Till very recently the *kodali* or hand-spade was the chief implement used in tillage, but ploughs are now in use.

The steep hill-sides are terraced, and the arable crops are grown on these flat terraces. Irrigation is required at some seasons, and is obtained from small channels which are led from hill-streams. The water has usually to be carried there from long distances.

The principal crops grown are rice and maize, which are sown in March and April and are harvested about December. Buck wheat is also extensively grown. Both wheat and barley are grown.

There is a great demand for good and hardy work-cattle, and for good milch cows. The principal grazing grounds are in the reserved forests. During the summer months, large numbers of cattle are sent by the *goalas* (cowherds) up the mountains of Nepal and Sikkim. Oilcakes, either mustard or linseed, are largely used for food, particularly for cows and cart bullocks.

There are three distinct breeds of cattle in the district, *(i)* the *siri*, *(ii)* the Nepali or *Pahari*, and *(iii)* the ordinary zebu plains breed found in the Terai. Of these, the siri is the best cart breed, on account of size and strength, and the cows are good milkers generally. The Nepali are the common cattle of the district. They are largely imported by the Nepalese settlers, for cultivating their small fields.

The wild Mithun or *Gayal* is a large animal, is immensely powerful, and is caught and tamed for work by the Bhutia tribes.

The forests in which the cattle usually graze, produce good fodder. Stall feeding is seldom required.

Proposals have been made to start a cattle-breeding farm at Kalimpong.—(EDITOR).

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THIRD REPORT ON THE SUGAR MILL AT BENIPORE FACTORY—BY PERCY JONES.—(PUBLISHED BY THE BEHAR PLANTERS' ASSOCIATION).

THE Behar Planters' Association have published a third report on the working of the Sugar Plant at Benipore (Tirhoot) in 1907-08. The Mill was worked during the past year at a profit of Rs. 2,365-1-0. Mr. Percy Jones ordered from Messrs. Broadbent & Co., a centrifugal machine of the pattern recommended by Mr. Hadi. It was, however, received late. It, therefore, began work with the *rab* after February the 15th. There was a large stock of *rab* on hand, which could not be worked off into sugar for nearly 1½ months. It had in that time settled and got hard, and so required more washing. This led to a loss of crystals.

The percentage of sugar obtained was very low, being only about 30 per cent. from the first quality *rab* and a little under that from molasses *rab*. However, with more experience a steady percentage of 33 per cent. first class quality of sugar was obtained. Mr. Jones could realise for this sugar from Rs. 9 to Rs. 10 per maund. Sugar inferior to this in quality was sold for about Rs. 6 a maund. Mr. Jones made several experiments in connection with the storage of *rab* and has found that shallow

tanks 6″ deep on a masonry floor are the best. In these, the *rab* cools quickly, and is ready to be spun off on the fifth day.

Mr. Jones had to deal with a cane-crop which was badly attacked by borer insects. This year, he has imported unaffected cane. His labourers have gained experience, and he hopes to show better results next year.—(EDITOR).

LIST OF AGRICULTURAL PUBLICATIONS IN INDIA DURING 1907-08.

No.	TITLE.	Author.	Where published.
	General Agriculture.		
1	Annual Report of the Imperial Department of Agriculture in India for the years 1905-06 and 1906-07. Price, 6 annas.	Inspector-General of Agriculture in India, Nagpur, Central Provinces.	Government Printing, India, Calcutta.
2	Proceedings of the Board of Agriculture in India, 1908. Price 8 annas.	Ditto.	Ditto.
3	Agricultural Journal of India, Vol. III, Parts I—III. Price, Rs. 2 for each part. Annual Subscription, Rs. 6 per annum.	Agricultural Research Institute, Pusa.	Messrs. Thacker, Spink & Co., Calcutta.
4	Standard Curriculum for Provincial Agricultural Colleges as recommended by the Board of Agriculture. Price, 4 annas.	Inspector-General of Agriculture in India, Nagpur, Central Provinces.	Government Printing, India, Calcutta.
5	Indian Cotton Seed: Its Industrial Possibilities. Price, 12 annas.	Frederic Noel-Paton, Director-General of Commercial Intelligence, India.	Ditto.
6	Proceedings of the Veterinary Conference held at Calcutta on the 10th, 11th and 12th February, 1908.	Inspector-General, Civil Veterinary Depratment, Simla.	
7	Agricultural Statistics of India, from 1901—1905-06. Price, Rs. 3-8.	Director-General of Commercial Intelligence.	Ditto.
8	Sun Flower in India—Agricultural Ledger, Ledger No. 1 of 1907. Price, 2 annas.	David Hooper, F.I.C., F.C.S., Superintendent, Industrial Section, Indian Museum, Calcutta.	Ditto.
9	Causes of hardness in the seeds of Indigo fera arrecta.	C. J. Bergtheil, Imperial Bacteriologist, and D. Day.	
10	Heeleaka Experimental Station: Investigations during 1905 and 1906.	Harold H. Mann, D.SC., F.I.C., F.L.S., Scientific Officer to the Indian Tea Association.	Indian Tea Association, Calcutta.
11	Second Report on the Sugar Mill at Benipur Factory.	Percy Jones	Behar Planters' Association, Mozufferpore.
12	Annual Report of the Behar Planters' Association for 1906-1907.	Behar Planters' Association.	Ditto.
13	Report of the Indigo Research Station, Sirsiah, for 1907-1908.	C. J. Bergtheil, Imperial Bacteriologist.	Ditto.
14	Third Annual Report of the Behar Planters' Association, Sirsiah Sub-committee, from 1st July 1907 to 31st December 1907.	Behar Planters' Association.	Ditto.
15	Third Report on the Sugar Mill at Benipur Factory.	Percy Jones.	Ditto.

LIST OF AGRICULTURAL PUBLICATIONS DURING 1907-08.—(*Continued*).

No.	Title.	Author.	Where published,
	General Agriculture—contd.		
16	Review of information on Burmese Peas and Beans so far collected in the office of the Reporter on Economic Products to the Government of India.	I. H. Burkill, M.A., Reporter on Economic Products to the Government of India.	Government Printing, India, Calcutta.
17	Conservation of Farm Yard manure. Leaflet No. 7 of 1907.	Department of Agriculture, Bengal.	Department of Agriculture, Bengal, Calcutta.
18	Ensilage for paddy. Leaflet No. 8 of 1907.	Ditto.	Ditto.
19	Weeds and their Suppression. Leaflet No. 9 of 1907.	Ditto.	Ditto.
20	Bonemeal and Saltpetre as manure for paddy. Leaflet No. 10 of 1907.	C. A. Oldham, I.C.S., Director of Agriculture, Bengal.	Ditto.
21	Short note on the Cultivation of Mangel Wurzel. Leaflet No. 11 of 1907.	Ditto.	Ditto.
22	Cassava. Leaflet No. 12 of 1907.	Department of Agriculture, Bengal.	Ditto.
23	Short instructions for the Improvement of Cotton by plant to plant selection. Leaflet No. 13 of 1907.	C. A. Oldham, I.C.S., Director of Agriculture, Bengal.	Ditto.
24	Jute Experiments in Bengal. Leaflet No. 1 of 1908.	F. Smith, B.Sc., Deputy Director of Agriculture, Bengal.	Department of Agriculture, Bengal, Calcutta.
25	Oats. Leaflet No. 2 of 1908 ...	Ditto.	Ditto.
26	Wheat. Leaflet No. 3 of 1908 ...	Ditto.	Ditto.
27	List of crops recommended for cultivation. Leaflet No. 4 of 1908.	Ditto.	Ditto.
28	The Bengal Seed, Manure and Implement Store. Leaflet No. 5 of 1908.	Department of Agriculture, Bengal.	Ditto.
29	Quarterly Journal of the Agricultural Dept., Bengal. Vol. I, Nos. 1—4. Price, Rs. 2.	Ditto.	Bengal Secretariat Book Depôt, Calcutta.
30	Annual Report of the Agricultural Department, Bengal, for the year ending 30th June 1907. Price, 8 annas.	Ditto.	Ditto.
31	Annual Report of the Burdwan Experimental Station for the year 1906-07. Price, 4 annas.	Ditto.	Ditto.
32	Annual Report of the Dumraon Experimental Station for the year 1906-07. Price, 2 annas.	Ditto.	Ditto.
33	Annual Report of the Cuttack Experimental Station for the year 1906-07. Price, 2 annas.	Ditto.	Ditto.
34	Season and Crop Report of Bengal, 1907-08. Price, 8 annas.	Ditto.	Ditto.
35	Agricultural Statistics of Bengal. Price, 8 annas.	Ditto.	Ditto.
36	Manual of Rules for the preparation of crop reports and Agricultural Statistics in Bengal (not for sale).	Ditto.	Bengal Secretariat Press, Calcutta.
37	Statement showing the normal areas under the principal crops in each district and the percentage of these areas on the normal net cropped area of the district (not for sale).	Ditto.	Ditto.

LIST OF AGRICULTURAL PUBLICATIONS DURING 1907-08.—(*Continued*).

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
38	Jute in Bengal	N. C. Chowdhry.	Muzumdar Library, Calcutta.
39	List of Local names of varieties and races of sugarcane grown in Bengal (not for sale).	Department of Agriculture, Bengal.	Bengal Secretariat Press, Calcutta.
40	A short note on wheat survey of Bengal, Departmental Record, No. 2 (not for sale).	D. N. Mukerji, M.A., M.R.A.C.	Ditto.
41	Catalogue of exhibits of the Bengal Agricultural Department, in the Indian Industrial and Agricultural Exhibition 1906-07 (not for sale).	Department of Agriculture, Bengal.	Ditto.
42	Report on enquiry into the decline of the silk industry of Bengal.	Ditto.	Ditto.
43	Monograph on breeds of cattle of Darjeeling district (not for sale).	D. Quinlan, M.R.C.V.S., Superintendent, C. V. Dept., Bengal.	Ditto.
44	Report of the Patna Divisional Agricultural Association, for the year ending 30th June, 1908.	Patna Divisional Agricultural Association.	Patna Divisional Agricultural Association, Bankipore.
45	Annual Report on the Administration of the Department of Agriculture, United Provinces, for the year ending 30th June, 1907. Price, 8 annas.	Department of Agriculture, United Provinces of Agra and Oudh.	Government Press, United Provinces of Agra and Oudh, Allahabad.
46	Annual Report on the Cawnpur Agricultural Station for the year ending 30th June, 1907.	Ditto.	Ditto.
47	Annual Report on the Jalaun (Orai) Agricultural Station for the year ending 30th June, 1907. Price, 8 annas.	Ditto.	Ditto.
48	Annual Report of the Aligarh Agricultural Station for the year ending 30th June, 1907. Price, 8 annas.	Ditto.	Ditto.
49	Annual Report of the Department of Agriculture, Punjab, for the year 1906-07. Price, 3 annas.	Department of Agriculture, Punjab.	"Civil & Military Gazette" Press, Lahore.
50	Annual Report of the Lyallpur Agricultural Station for the year 1906-07. Price, 6 annas.	Ditto.	Ditto.
51	Annual Report of the Government Agri-Horticultural Gardens, Lahore, for the year 1907-08.	Ditto.	Ditto.
52	Season and Crop Report of the Punjab for 1906-07. Price, 9 annas.	Ditto.	Ditto.
53	Annual Report of the Department of Agriculture, Bombay Presidency, for the year 1906-07. Price, 4 annas.	Department of Agriculture, Bombay Presidency.	Government Central Press, Bombay.
54	Annual Report of the Experimental Work of the Surat Agricultural Station for the year 1906-07. Price, 6 annas.	Ditto.	Ditto.
55	Annual Report of the Experimental Work of the Nadiad Agricultural Station for the year 1906-07. Price, 6 annas.	Ditto.	Ditto.

LIST OF AGRICULTURAL PUBLICATIONS DURING 1907-08.—(*Continued*).

No.	Title.	Author.	Where Published.
	General Agriculture—contd.		
56	Annual Report of the Experimental work of the Dharwar Agricultural Station for the year 1906-07. Price, 6 annas.	Department of Agriculture, Bombay Presidency.	Government Central Press, Bombay.
57	Annual Report of the Experimental work of the Dhulia Agricultural Station for the year 1906-07. Price, 4 annas.	Ditto.	Ditto.
58	Annual Report of the Poona Agricultural Station for the year 1906-07, including Kirkee Civil Dairy and Lanowli Agricultural Stations. Price, 7 annas.	Ditto.	Ditto.
59	Annual Report of the Manjri Agricultural Station and the Baramati Demonstration Station for the year 1906-07. Price, 5 annas.	Ditto.	Ditto.
60	Annual Report of the Ganeshkhind Botanical Station for the year 1906-07. Price, 5 annas.	Ditto.	Ditto.
61	Annual Report of the Bassein Botanical and Agricultural Station for the year 1906-07. Price, 4 annas.	Ditto	Ditto.
62	Annual Report of the Mirpurkhas Agricultural Station for the year 1906-07. Price, 3 annas.	Ditto.	Ditto.
63	Season and Crop Report of the Bombay Presidency for the year 1906-07. Price, 7 annas.	Ditto.	Ditto.
64	Proceedings of the Agricultural Conference held at Ahmedabad in November 1907. Price, 7 annas.	Ditto.	Ditto.
65	Poona Agricultural College Calendar for the year 1908-09.	Ditto.	Shri Shetkari Press, Poona.
66	Report on the Operations of the Department of Agriculture for the year 1906-07. Price, 8 annas.	Department of Agriculture, Madras.	Government Press, Madras.
67	Scientific Report of the Attur Agricultural Station for the year 1906-07. Price, 2 annas.	Ditto.	Ditto.
68	Scientific Report of the Hagari Agricultural Station for the year 1906-07. Price, 4 annas.	Ditto.	Ditto.
69	Scientific Report of the Bellary Agricultural Station for the year 1906-07. Price, 6 annas.	Ditto.	Ditto.
70	Scientific Report of the Palur Agricultural Station for the year 1906-07. Price, 3 annas.	Ditto.	Ditto.
71	Scientific Report of the Koilpatti Agricultural Station for the year 1906-07. Price, 6 annas.	Ditto.	Ditto.
72	Scientific Report of the Samalkota Agricultural Station for the year 1906-07. Price, 3 annas.	Ditto.	Ditto.

LIST OF AGRICULTURAL PUBLICATIONS DURING 1907-08.—(*Continued*).

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
73	Notes on Fig cultivation in South India and peculiarities in Viticulture in Penukonda in the Anantpur District. Bulletin No. 57. Price, 1 anna.	Rao Bahadur C. K. Subba Rao, B.A., Ag. Government Botanist, Madras.	Government Press, Madras.*
74	The cultivation of Groundnuts. Bulletin No. 58. Price 9 pies.	H. C. Sampson, B.Sc., Deputy Director of Agriculture, Southern Circle, Madras Presidency.	Ditto.
75	Note on Jute cultivation (in Tamil) Leaflet. Distributed free to ryots.	Ditto.	Ditto.
76	Madras Agricultural Calendar 1908. Price, 0-1-6.	Department of Agriculture, Madras.	Ditto.
77	Note on How to water fruit trees. Leaflet with Tamil and Telugu translations. Distributed free to ryots.	Ditto.	Ditto.
78	The introduction of improvements into Indian Agriculture, Leaflet.	D. Clouston, M.A., B.Sc., Deputy Director of Agriculture, Central Provinces.	Secretariat Press, Nagpur.
79	Sann-hemp, Ambari and Agave as fibre crops in the Central Provinces. Leaflet.	Ditto.	Ditto.
80	Seoner Juar. Leaflet.... ...	Ditto.	Desha Sevak Press, Nagpur.
81	Safeda. Leaflet.	Ditto.	Ditto.
82	Medium Paddy. Leaflet. ...	Ditto.	Ditto.
83	Raskadam and Nasick early paddies. Leaflet.	Ditto.	Ditto.
84	Gurmatia, late paddy. Leaflet. ...	Ditto.	Ditto.
85	Groundnut. Leaflet	Ditto.	Ditto.
86	Upland Georgian and Buri Kapas. Leaflet.	Ditto.	Ditto.
87	Dry Earth Method of Conserving urine. Leaflet.	Ditto.	Ditto.
88	Agricultural Gazette. A monthly publication. Price, 2 annas per copy.	Ditto.	Ditto.
89	Hints to Superintendents of Experiment Stations.	Ditto.	Secretariat Press, Nagpur.
90	Report on the Department of Agriculture, Central Provinces. Price, Re. 1.	Department of Agriculture, Central Provinces.	Ditto.
91	Report on the Agricultural Stations in the Central Provinces. Price, Re. 1.	Ditto,	Ditto.
92	Report on the Provincial and District Gardens in the Central Provinces. Price, Re. 1.	Ditto.	Ditto.
93	Wheat grown in the Central Provinces. Bulletin, Price, Re. 1.	G. Evans, B.A., B.Sc., Deputy Director of Agriculture, Central Provinces.	Ditto.
94	A few simple Agricultural improvements. Bulletin No. 16 of 1907.	Rai Bahadur B. C. Basu, M.R.A.C., Asst. Director of Agriculture, E. B. & Assam.	Eastern Bengal and Assam Secretariat Press, Shillong.
95	Jhum cultivation in Lumding. Bulletin No. 18 of 1908.	Ditto.	Ditto.
96	Coffee cultivation in the Khasi Hills. Bulletin No. 20 of 1908.	Ditto.	Ditto.

* With Tamil and Telegu translations.

LIST OF AGRICULTURAL PUBLICATIONS DURING 1907-08.—(*Continued*).

No.	Title.	Author.	Where published.
		General Agriculture—concld.	
97	Jute cultivation. Leaflet No. 1 of 1907.	Robert S. Finlow, B. SC., Fibre Expert to the Government of E. B. & Assam.	Eastern Bengal and Assam Secretariat Press, Shillong.*
98	Jute in rotation with paddy in the same year and its effect on food crops, Leaflet.	S. G. Hart, I.C.S., Director of Agriculture, E. B. & Assam.	Ditto.
99	Annual Report of the Department of Agriculture, E. B. and Assam, for 1906-07. Price, 8 annas.	Department of Agriculture, E. B. & Assam.	Ditto.
100	Annual Report on the Agricultural stations in Eastern Bengal & Assam for 1906-07. Price, 12 annas.	Ditto.	Ditto.
101	Annual Report of the Tropical Plantation at Wahjain for the year ending 30th June 1907. Price, 2 annas.	Ditto.	Ditto.
102	Annual Report of the Rajshahi Agricultural Station for 1906-07. Price, 2 annas.	Ditto.	Ditto.
103	Annual Report of the Rangpur Agricultural Station for 1906-07. Price, 2 annas.	Ditto.	Ditto.
104	Annual Report of the Jorhat Agricultural Station for 1906-07. Price, 2 annas.	Ditto.	Ditto.
105	Annual Report of the Upper Shillong Agricultural Station for 1906-07. Price, 2 annas.	Ditto.	Ditto.
106	Annual Report of the Shillong Fruit Garden for 1906-07. Price, 2 annas.	Ditto.	Ditto.
107	Wheat cultivation, Leaflet No. 1.	Department of Agriculture, Burma.	Government Press, Burma, Rangoon.
108	Farmyard manure, Dung or cattle manure. Leaflet No. 3.	Ditto.	Ditto.
109	The cultivation of Ground-nut. Leaflet No. 4.	Ditto.	Ditto.
110	Annual Report of the Department of Agriculture, Burma, for the year ending 30th June 1907.	Ditto.	Ditto.
111	Introduction of Moulmein paddy into the Akyab District. Leaflet No. 6.	Ditto.	Ditto.
112	Annual Report of the Board of Scientific Advice for the year 1906-07. Price, Re. 1.	Board of Scientific Advice, Calcutta.	Government Printing, India, Calcutta.
		Agricultural Chemistry.	
1	The Loss of Water from soil during dry weather. Price, Rs. 2.	J. Walter Leather, Ph.D., F.I.C., F.C.S., Imperial Agricultural Chemist, Pusa.	Memoirs of the Department of Agriculture, Vol. I, No. 6. Messrs. Thacker, Spink & Co., Calcutta.
2	Official and Recommended methods for use in Chemical Laboratories of the Departments of Agriculture in India. Bulletin No. 8 of the Agricultural Research Institute, Pusa. Price, annas 4.	Ditto.	Government Printing, India, Calcutta.

* With Bengali and Assamese translations.

LIST OF AGRICULTURAL PUBLICATIONS DURING 1907-08.—(*Continued*).

No.	Title.	Author.	Where published.
		Agricultural Chemistry—concld.	
3	Annual Report of the Laboratory Work of the Agricultural Chemist of the Bombay Presidency. Price, annas 4.	Department of Agriculture, Bombay.	Government Central Press, Bombay.
4	Report to the Government of India containing an account of the Research Work on Indigo performed in the University of Leeds, 1905-07. Price, 3 shillings.	W. Popplewell Bloxam, B.SC. (Lond.), F.C.S., F.I.C.	Published by order of His Majesty's Secretary of State for India in Council.
5	Report of Experiments to test the value of manures for crops in Behar.	J. W. Leather, Ph.D., F.I.C., F.C.S., Imperial Agricultural Chemist, Pusa; H. E. Annett, B.SC. Supernumerary Chemist, Pusa, and W. Roberts, B.SC., Supernumerary Agriculturist, Pusa.	Behar Planters' Association, Mozufferpore.
		Mycology.	
1	Fungi Indiæ Orientalis, Part II.	E. J. Butler, M.B., F.L.S., (in collaboration with H. Sydow).	Annales Mycologici, Vol. V, No. 6 of 1907.
2	Report on trials of the South African Locust Fungus in India. Bulletin No. 5 of the Agricultural Research Institute, Pusa. Price, 2 annas.	E. J. Butler, M.B., F.L.S., Imperial Mycologist, Pusa, and H. Maxwell Lefroy, M.A., F.E.S., F.Z.S., Imperial Entomologist, Pusa.	Government Printing, India, Calcutta.
3	Report on Cocoanut Palm Disease in Travancore. Bulletin No. 9 of the Agricultural Research Institute, Pusa. Price, 6 annas.	E. J. Butler, M.B., F.L.S., Imperial Mycologist, Pusa.	Ditto.
4	Palmyra Palm Disease in Godaveri. Leaflet.	Ditto.	Ditto.
5	Cocoanut Palm Disease in Travancore. Leaflet.	Ditto.	Ditto.
6	Sugarcane red rot in Burma. Leaflet.	Ditto.	Ditto.
7	Bordeaux Mixture as a preventive of potato disease. Bulletin No. 19.	Rai Bahadur B. C. Basu, M.R.A.C., Assistant Director of Agriculture, E. B. & Assam.	Eastern Bengal and Assam Secretariat Press, Shillong.
8	Note on the Orange Blight in the Khasi Hills. Leaflet.	Ditto.	Ditto.
9	The Haustorium of Olax Scandens. Price, Rs. 2-8.	C. A. Barber, M.A., F.L.S., Government Botanist, Madras.	Memoirs of the Department of Agriculture in India, Botanical Series, Vol. II, No. 4. Messrs. Thacker, Spink & Co., Calcutta.

LIST OF AGRICULTURAL PUBLICATIONS DURING 1907-08.—(*Continued*).

No.	Title.	Author.	Where published.
		Economic Botany.	
1	Immune Wheats. ...	A. Howard, M.A., A.R.C.S., F.C.S., F.L.S., Imperial Economic Botanist, Pusa, (in collaboration with G. L. C. Howard.)	Journal of Agricultural Science, Vol. II, Part III, 1907.
2	Some difficulties in Sugarcane Experiments.	A. Howard, M.A., A.R.C.S., F.C.S., F.L.S., Imperial Economic Botanist, Pusa.	International Sugar Journal, September 1907.
3	Notes on Agave and Furcrœa in India. Bulletin No. 8 of Bengal Deparment of Agriculture.	J. R. Drummond and D. Prain.	Bengal Secretariat Press, Calcutta.
4	The Indian Cottons. Price, Rs. 7-8.	G. A. Gammié, F.L.S., Economic Botanist to the Government of Bombay.	Memoirs of the Department of Agriculture, Vol. II, No. 2. Messrs. Thacker, Spink & Co.
5	Note on Toxic substance excreted by the roots of plants. Price, Re. 1-8.	F. Fletcher, M.A., B.Sc., Deputy Director of Agriculture.	Memoirs of the Department of Agriculture, Vol. II, No. 3. Messrs. Thacker, Spink & Co., Calcutta.
		Entomology.	
1	The Mustard Saw-fly. Price, Re. 1.	H. Maxwell-Lefroy, M.A., F.E.S., F.Z.S., Imperial Entomologist, Pusa, and C. C. Ghosh, B.A.	Memoirs of the Department of Agriculture, Vol I, No. 6, Messrs. Thacker, Spink & Co., Calcutta.
2	The Rice Bug. Price, Re. 1.	Ditto.	Memoirs of the Department of Agriculture, Vol. II, No. 1. Messrs. Thacker, Spink & Co., Calcutta.
3	Remarks on Indian Scale Insects (coccidæ) Part III. Price, Re. 1-8.	E. E. Green, F.E.S., F.Z.S., Government Entomologist, Ceylon.	Memoirs of the Department of Agriculture, Vol. II, No. 2. Messrs. Thacker, Spink & Co., Calcutta.
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6	The Tobacco Caterp llar. Price, Re. 1-8.	Ditto.	Memoirs of the Department of Agriculture in India, Vol. II, No. 5. Messrs. Thacker, Spink & Co., Calcutta.
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11	Chafers (Po Kyaing Gaung and Chafer Grubs—Po Di Gaung). Leaflet No. 1.	Department of Agriculture, Burma.	Government Press, Burma, Rangoon.